

# Artificial Intelligence for Techies

A Hands-on Approach

Good Morning!

- 1) Download the presentation slides and activities worksheet at <https://bit.ly/3qiGIHu>
- 2) We will start at 9am sharp

Sit back and relax for now ☺



# Programme

---

Section 1:	Fundamental of Artificial Intelligence
Section 2:	Machine Learning and Deep Learning
Section 3:	Google Teachable machine CNN and RNN
Section 4:	Lunch
Section 5:	AI Frameworks, software and hardware
Section 6:	AI Services
Section 7:	Practical Text Analytics using AI services
Section 8:	Practical Computer Vision using a programming framework
Section 9:	Application of AI (Bonus)



# Introduction of trainer

---



**Name**  
Zack Toh

**Telegram**  
[@zacktohsh](https://t.me/zacktohsh)

**Email**  
[Zack\\_toh@rp.edu.sg](mailto:Zack_toh@rp.edu.sg)



# Past Projects (Crowd Detection) (18RIGO09)

**SSDv1**



**SSDv2**

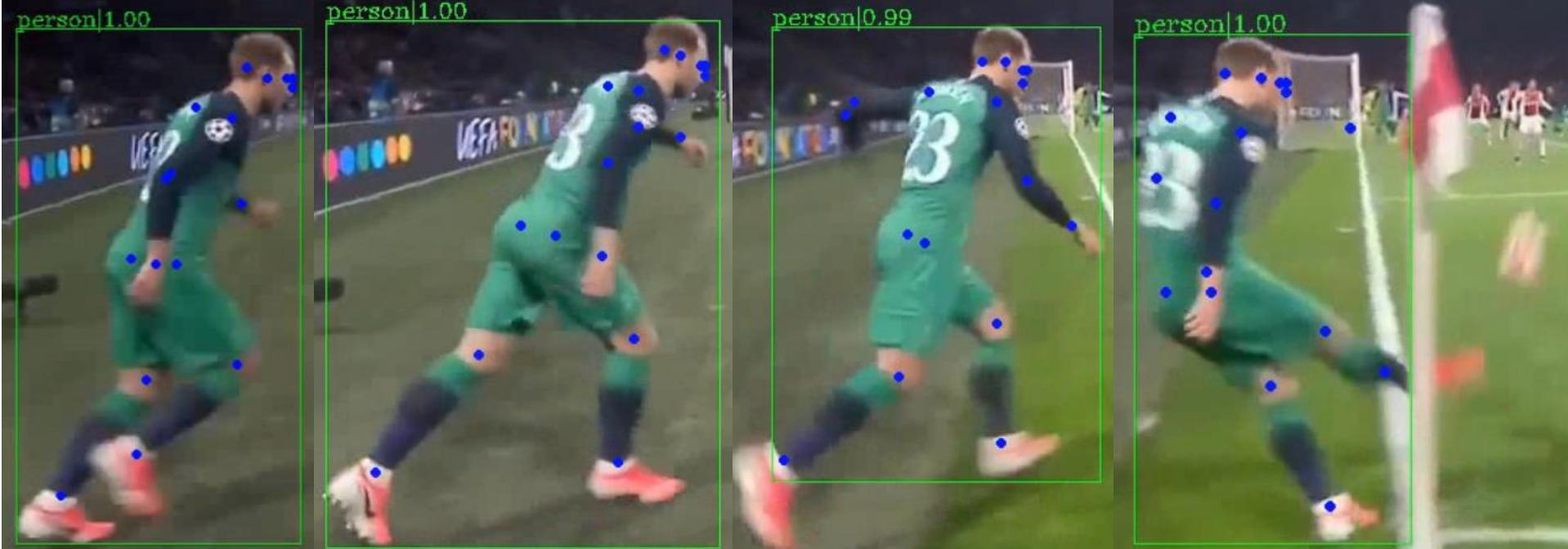


**Yolo**



# Deep Learning for Sports Tagging (19RBF07)

Contextual awareness is the holy grail of computer vision. It aims at equipping a machine with the ability of deciphering what is happening in any given image. The automated tagging in sports is a new emerging area in sports industry. This project would contribute tremendously to the productivity and efficiency of sports tagging and dramatically reduce the labor needed in curating the sports statistic. The proposed prototype has high commercialization potential as shared by current sports tagging companies (e.g., Dartfish SA, Hudl and Prozone).



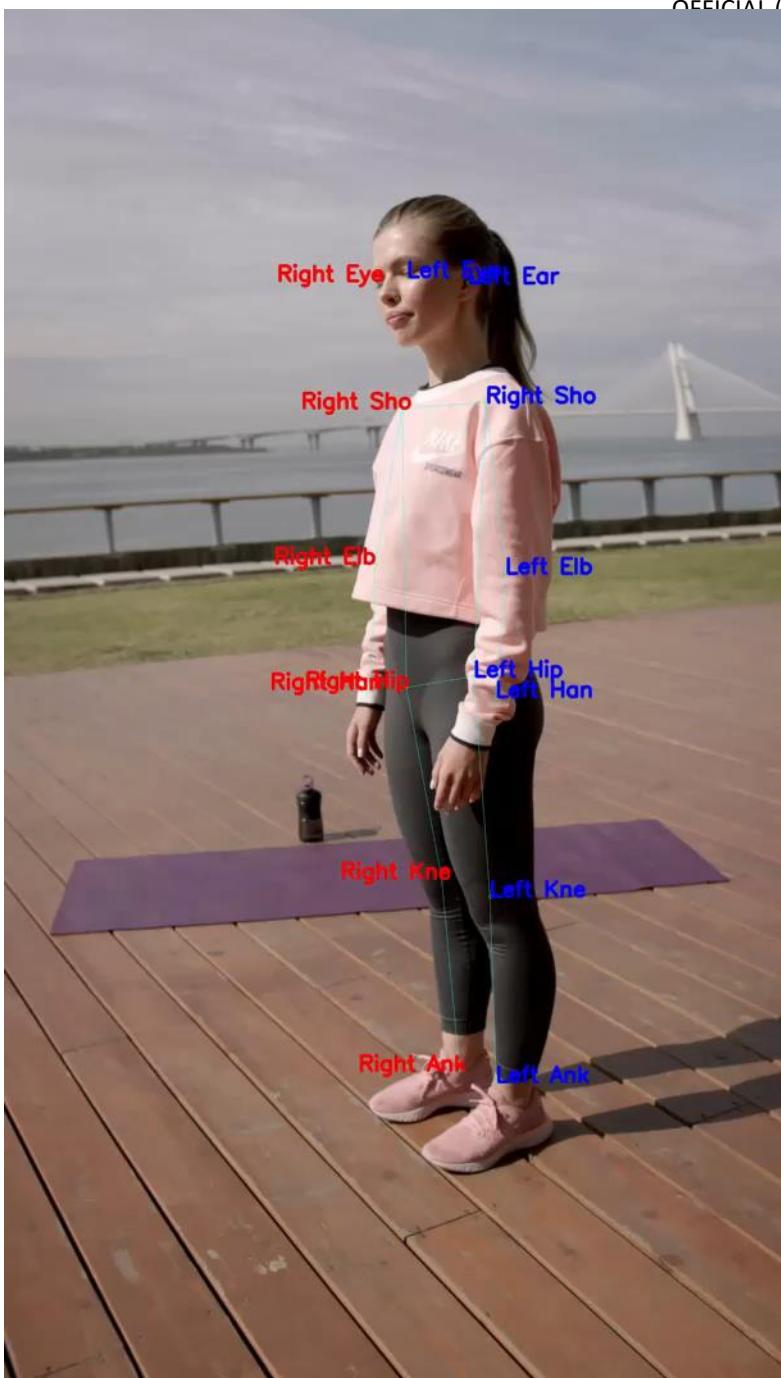
# Processed Throw-in





# Innovative Approach and Value (Current)





## Pose Recognition

---

Video obtained from: <https://www.pexels.com/>

Pose generated with Posenet



# Talk to flower

---



[https://www.youtube.com/watch?v=nsPQvZm\\_rgM](https://www.youtube.com/watch?v=nsPQvZm_rgM) 9

# What is Artificial Intelligence?

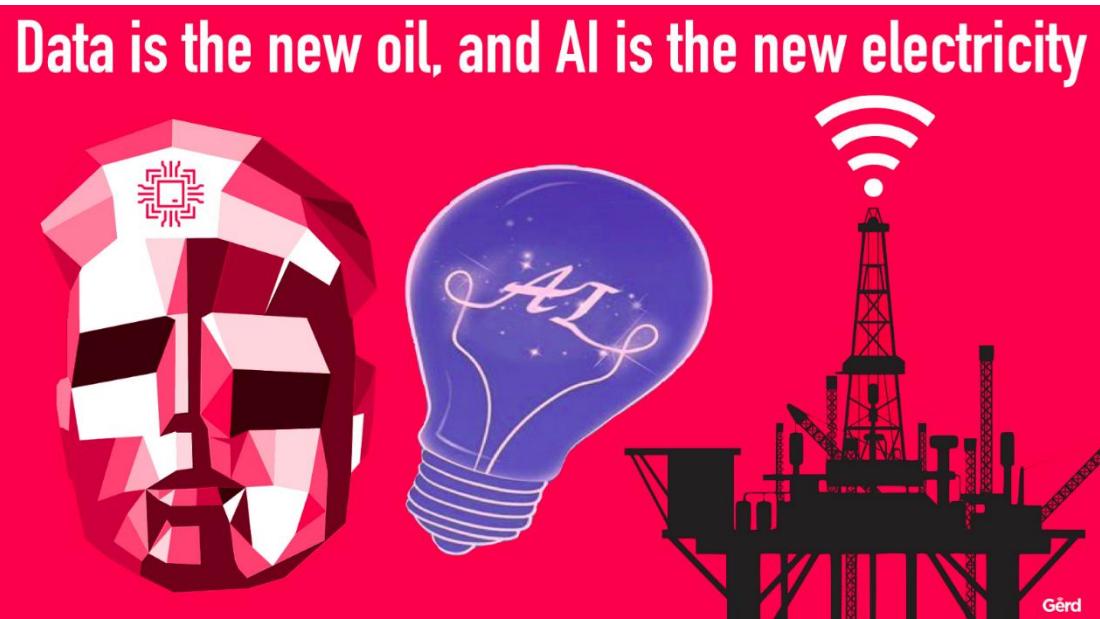
- The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, and translation between languages.” – Google



# AI is the new electricity

**"About 100 years ago, electricity transformed every major industry. AI has advanced to the point where it has the power to transform" every major sector in coming years.—**

Andrew Ng





# History of AI

## A.I. TIMELINE

**1950**

**TURING TEST**

Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

**1955**

**A.I. BORN**

Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"

**1961**

**UNIMATE**

First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line



**1964**

**ELIZA**

Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans



**1966**

**SHAKY**

The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions



**A.I.**

**WINTER**

Many false starts and dead-ends leave A.I. out in the cold



**1997**

**DEEP BLUE**

Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov



**1998**

**KISMET**

Cynthia Breazeal at MIT introduces Kismet, an emotionally intelligent robot insofar as it detects and responds to people's feelings



**1999**

**AIBO**

Sony launches first consumer robot pet dog AIBO (AI robot) with skills and personality that develop over time



**2002**

**ROOMBA**

First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes



**2011**

**SIRI**

Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S



**2011**

**WATSON**

IBM's question answering computer Watson wins first place on popular \$1M prize television quiz show Jeopardy



**2014**

**EUGENE**

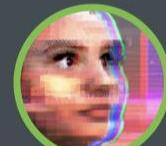
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human



**2014**

**ALEXA**

Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks



**2016**

**TAY**

Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments



**2017**

**ALPHAGO**

Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number ( $2^{170}$ ) of possible positions



# Why???





# Bigger Datasets

In 2020, it is expected that:

- The average internet user will generate ~1.5 GB of traffic per day.
- A smart hospital will generate 3,000 GB/day.
- Self-driving cars are each generating over 4,000 GB/day.
- Connected planes will generate 40,000 gigabytes per day.
- A connected factory will generate 1 million gigabytes per day.



**2019**  
*every*  
**MINUTE**  
*of* **the** *DAY*

PRESENTED BY DOMO

#LOVE

IS POSTED

**23,211**

TIMES

TWITCH

USERS VIEW

**1,000,000**

VIDEOS

TUMBLR

USERS PUBLISH

**92,340**

POSTS

**390,030**

APPS ARE DOWNLOADED

**18,100,000**

TEXTS ARE SENT

GOOGLE

CONDUCTS

**4,497,420**

SEARCHES

TINDER

USERS SWIPE

**1,400,000**

TIMES

GIPHY

SERVES UP

**4,800,000**

GIFS

NETFLIX

USERS STREAM

**694,444<sup>hrs</sup>**

OF VIDEO

GRUBHUB

RECEIVES

**8,683**

ORDERS

INSTAGRAM

USERS POST

**277,777**

STORIES

YOUTUBE

USERS WATCH

**4,500,000**

VIDEOS

TWITTER

USERS SEND

**511,200**

TWEETS

**188,000,000**

EMAILS ARE SENT

SKYPE

USERS MAKE

**231,840**

CALLS

INSTAGRAM

USERS POST

**55,140**

PHOTOS

AIRBNB

BOOKS

**1,389**

RESERVATIONS

AMERICANS

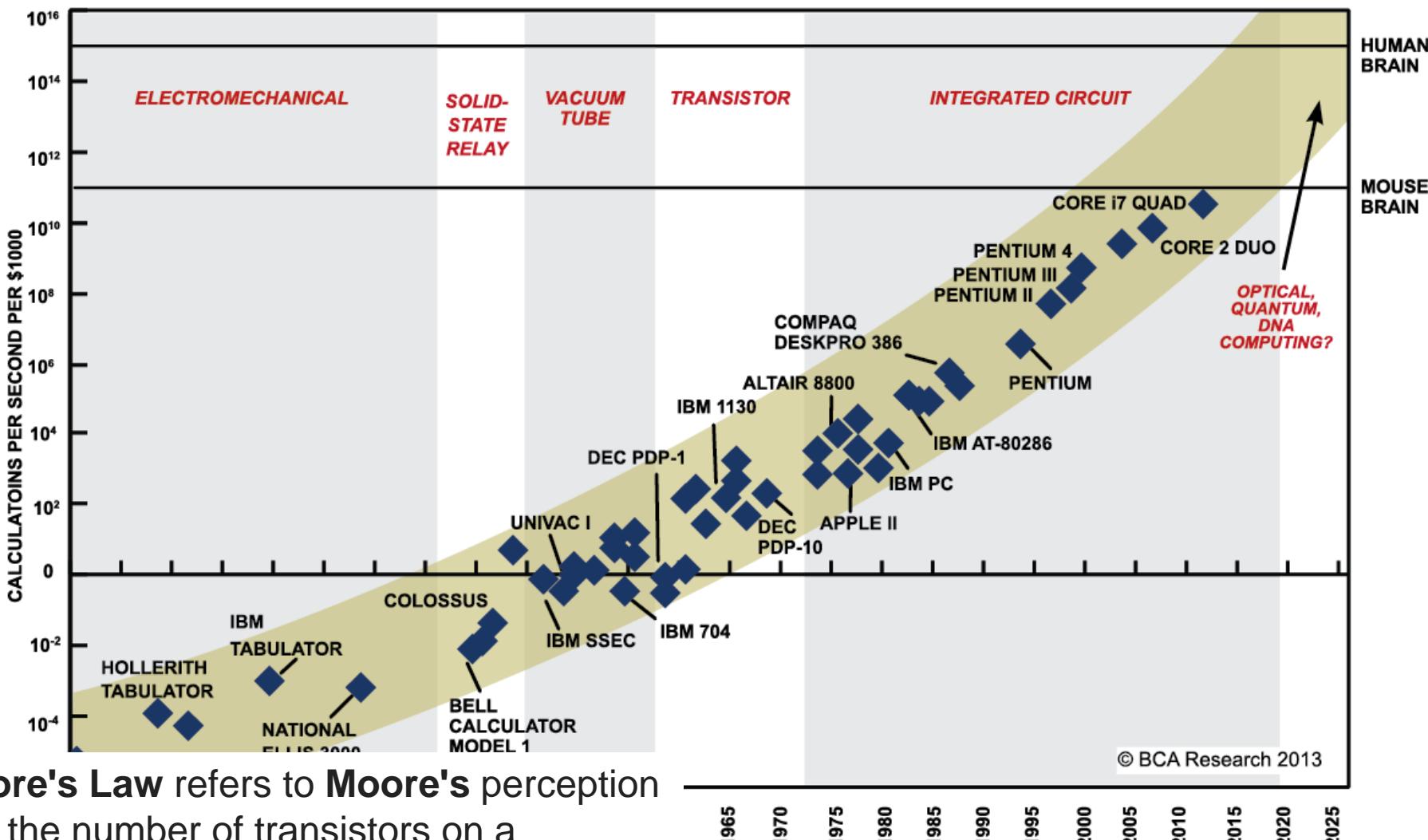
USE

**4,416,720<sup>GB</sup>**

OF INTERNET DATA



# Moore's Law



© BCA Research 2013

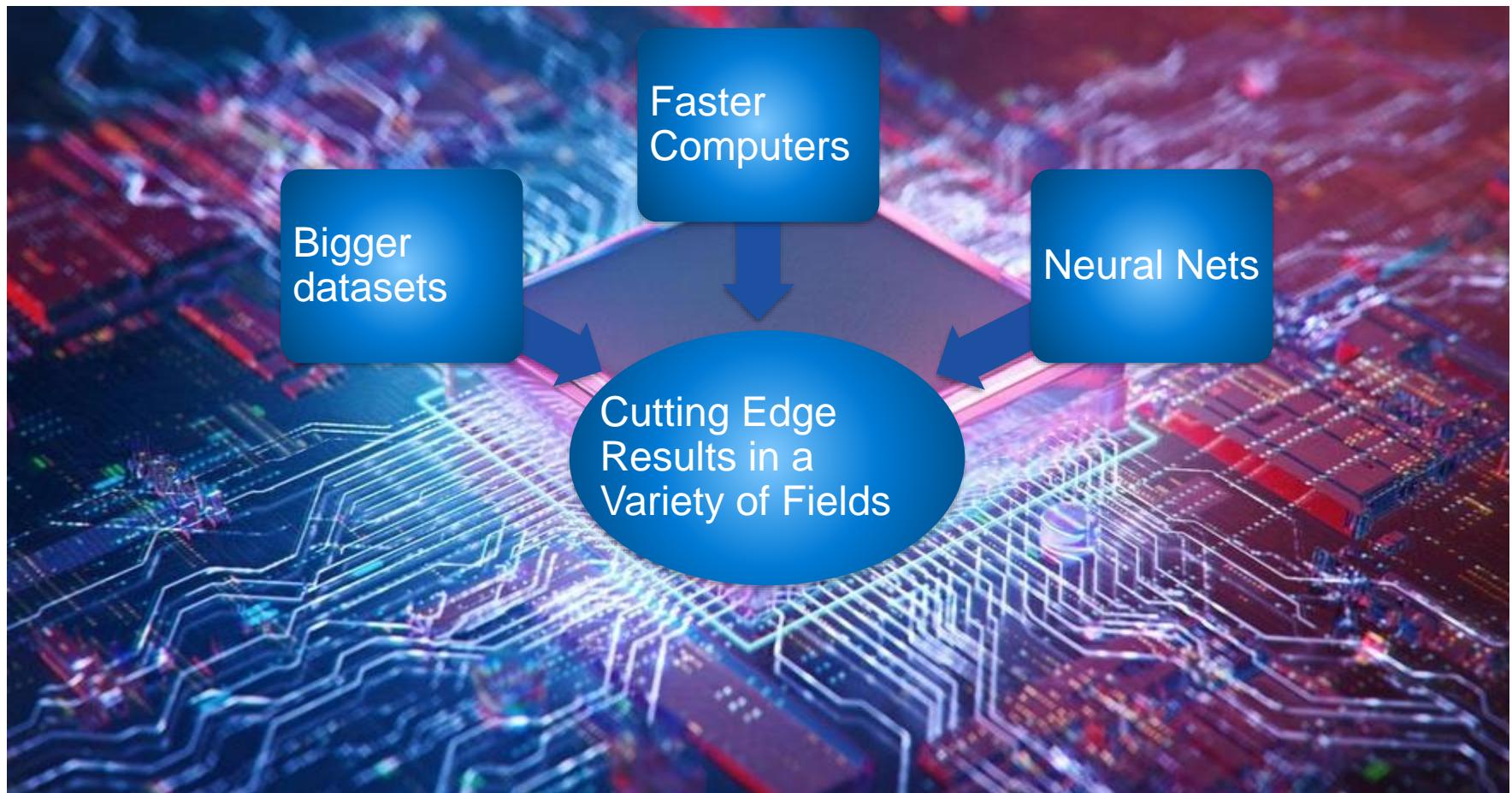
Moore's Law refers to Moore's perception that the number of transistors on a microchip doubles every two years, though the cost of computers is halved.

ND BIOLOGY", P.67, THE VIKING PRESS, 2006. DATAPoints BETWEEN 2000 AND



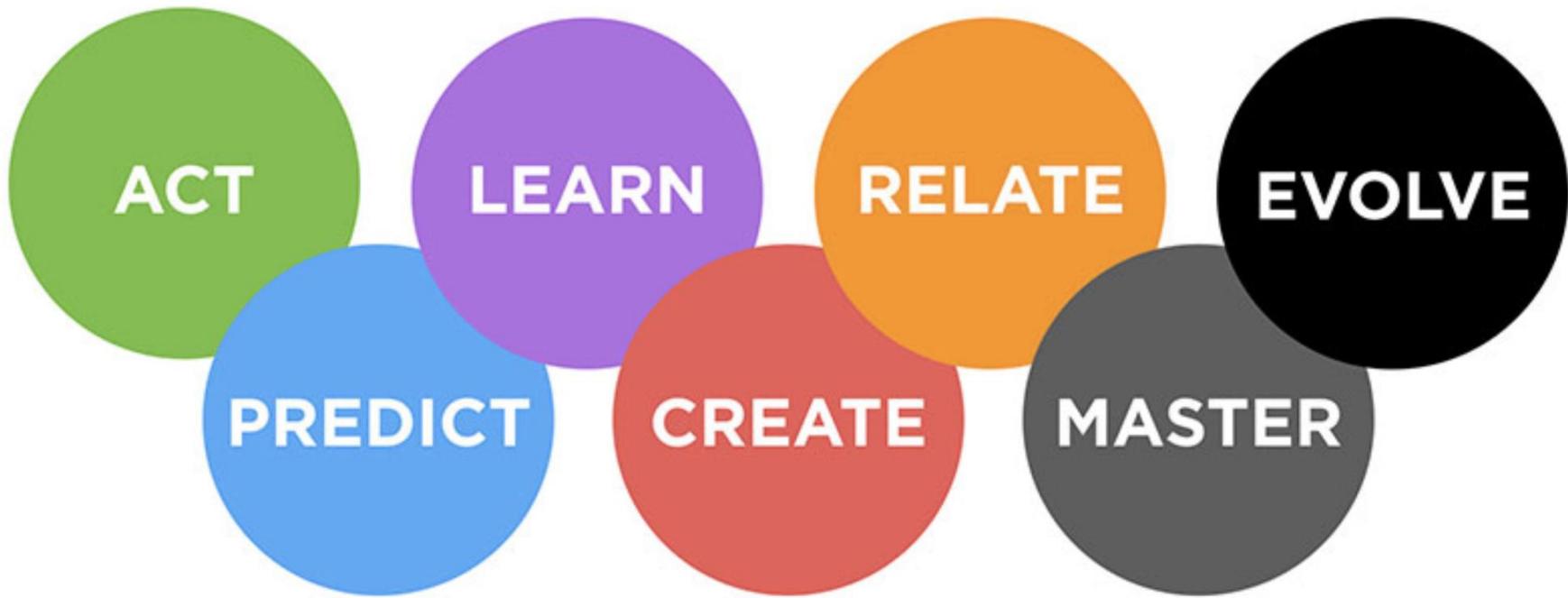
# AI Hardware

**Faster hardware** is one of the key areas driving the modern era of AI.





# MACHINE INTELLIGENCE CONTINUUM



The MIC represents a continuum from simple, scripted automation to superhuman intelligence and highlights the functional capabilities of different levels of machine intelligence.



# Systems that Acts





# Systems that Predicts

---

**Hillary Clinton** has an  
**85% chance** to win.

Last updated Tuesday, November 8 at 10:20 PM ET

CHANCE OF WINNING



85%

Hillary Clinton



15%

Donald J. Trump



# Systems that Learns





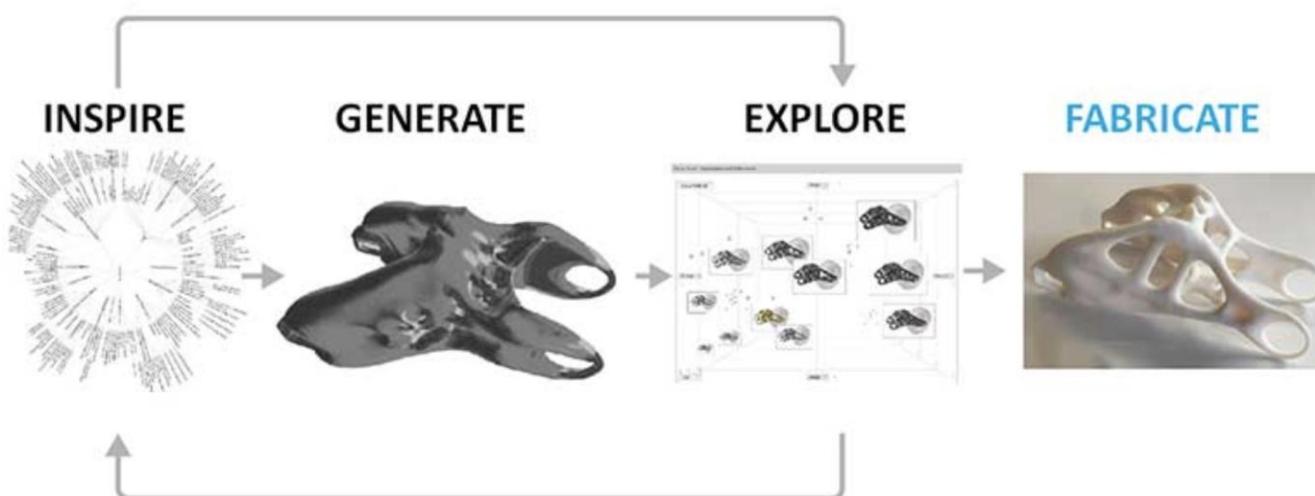
# Systems that Create



Generated story about image  
Model: Romantic Novels

*"He was a shirtless man in the back of his mind, and I let out a curse as he leaned over to kiss me on the shoulder."*

*"He wanted to strangle me, considering the beautiful boy I'd become wearing his boxers."*





# I AM AI

---

I am AI (Variation)

AIVA (Artificial Intelligence Virtual Artist)

00:00

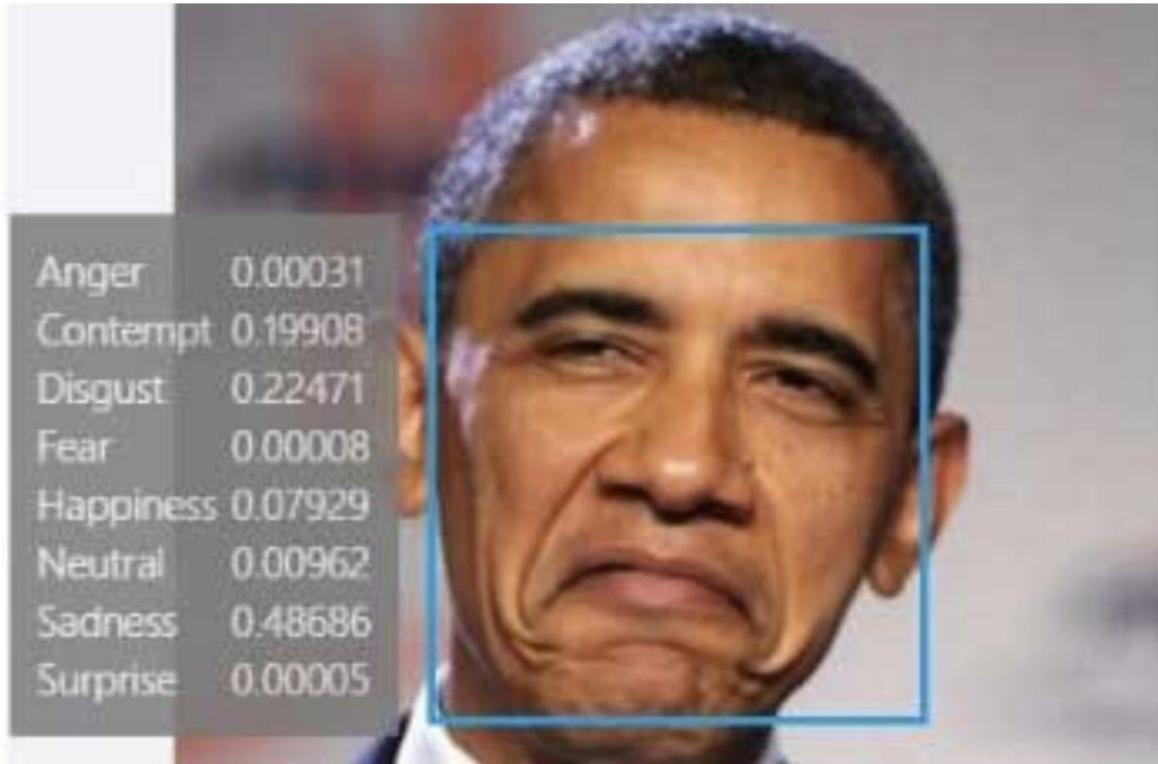


[www.aiva.ai](http://www.aiva.ai)



# Systems that Relate

---



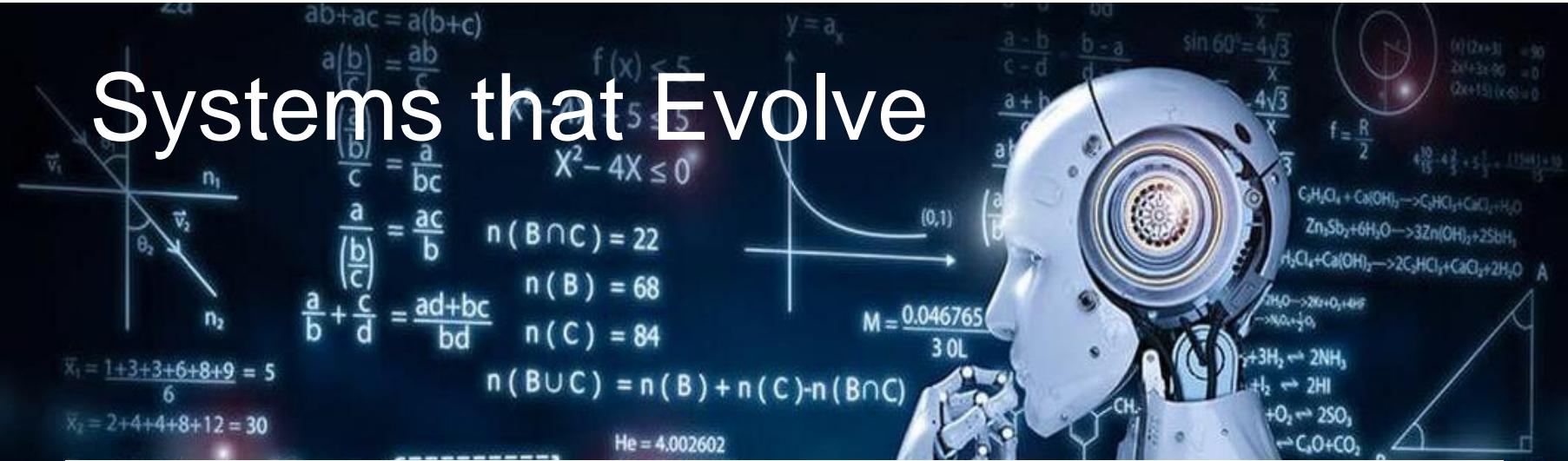


# Systems that Master

---

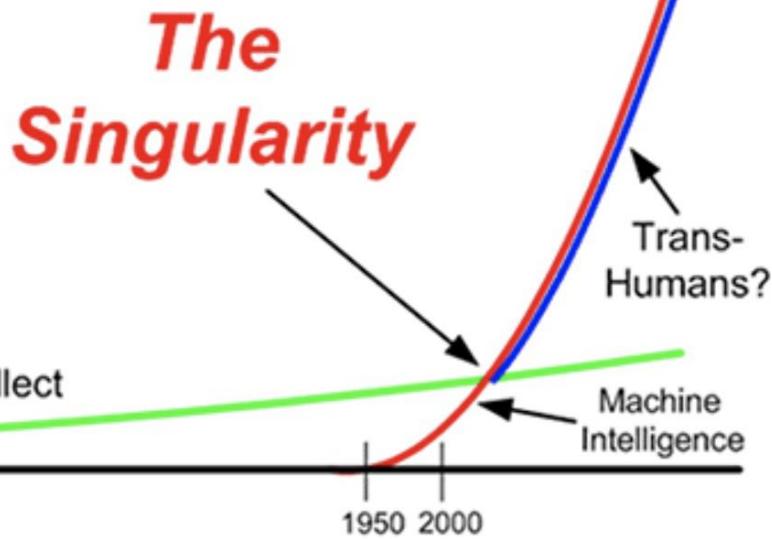


# Systems that Evolve



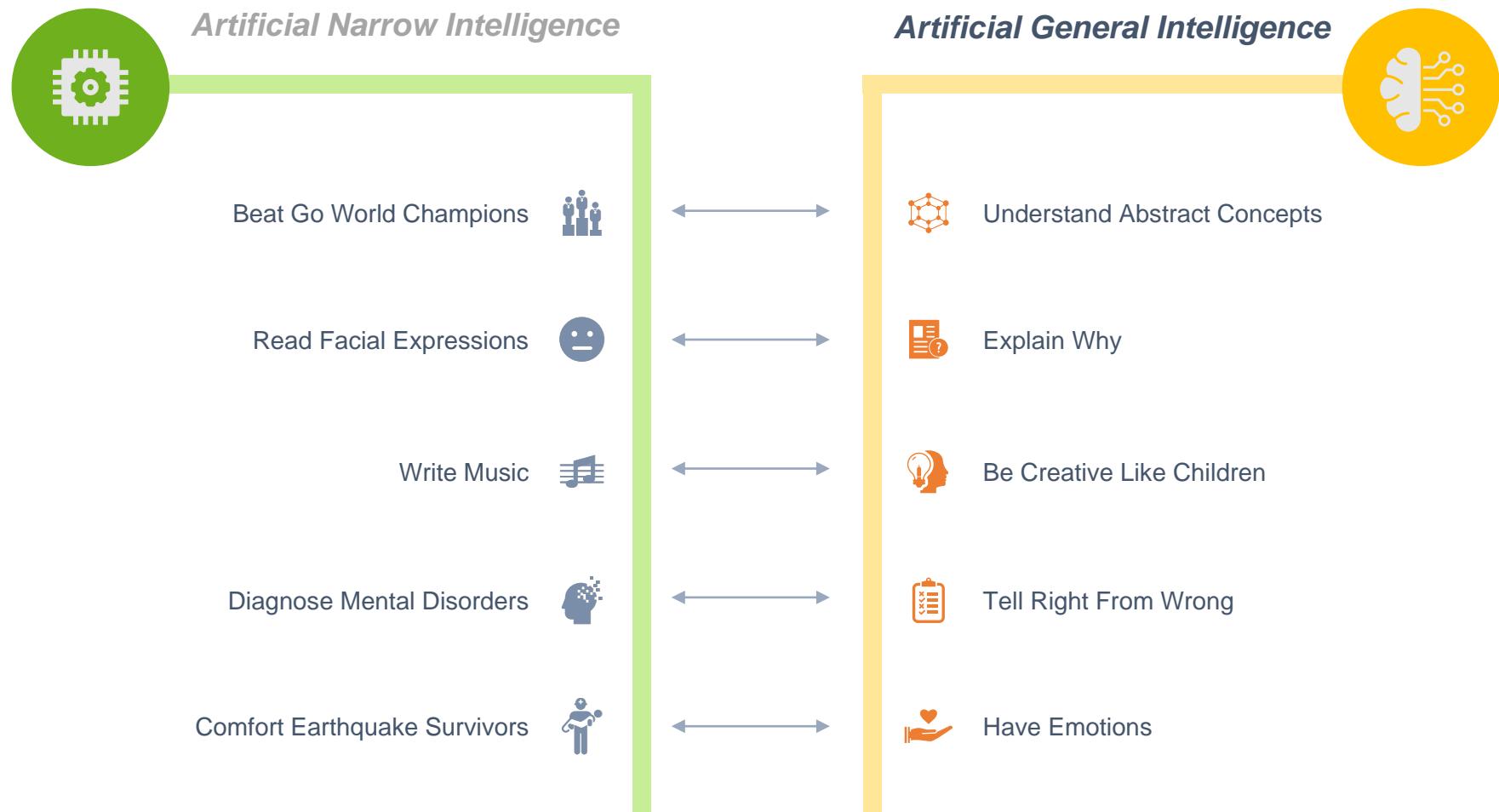
The **technological singularity**—also, simply, **the singularity**—is a hypothetical point in time at which technological growth becomes uncontrollable and irreversible, resulting in unforeseeable changes to human civilization.

- Wikipedia





# Artificial Narrow Intelligence vs Artificial General Intelligence





# Mapping Human Perceptions to AI-enabled Capabilities

Vision	Computer Vision	Conversational Interface  Licensed to Seow Khee Wei
Hearing	Speech Recognition / Audio Recognition	
Understanding	Natural Language Processing	
Speaking	Text to Speech, Speech to Text, Voice (Tone and Accent) Imitation	
Feeling	Emotion AI (detection and analysis of complex human emotions is currently conducted through diverse mechanisms such as natural language processing (NLP), voice patterns, facial expressions, and physiology)	
Smelling	The data of smell are relatively seldom and more difficult to collect compared to visual, text, or voice datasets. The development of an electronic nose to recognize smell has been long researched, but its development with AI techniques is still in an early stage	
Touching	Robot	



# 15 Mins Break

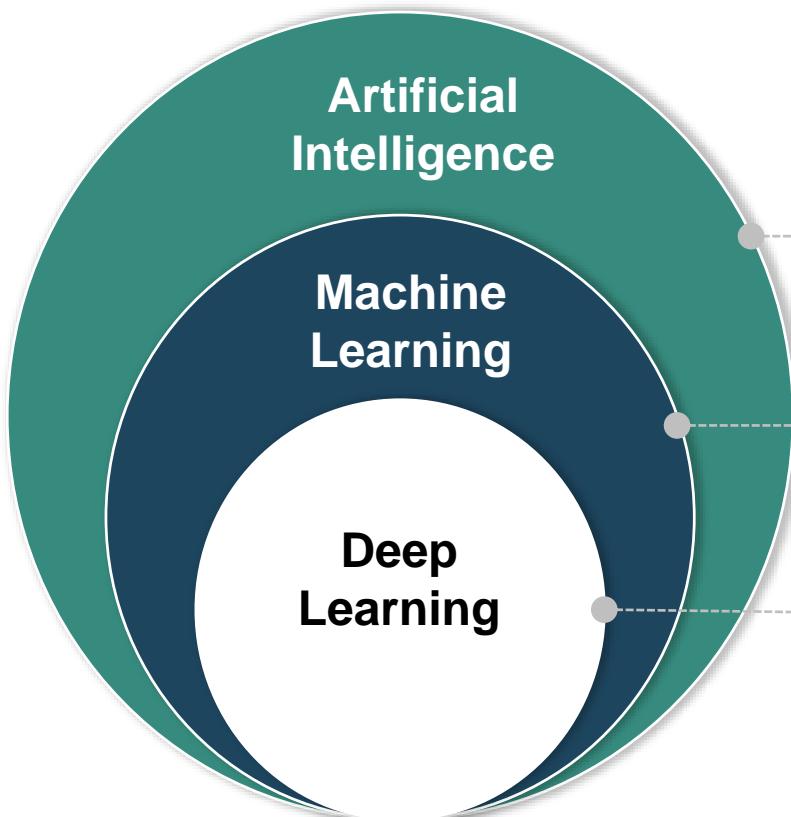


[bit.ly/top10\\_2020](https://bit.ly/top10_2020)





# Definition



## Artificial Intelligence

Any technique which enables computers to sense, reason, act and adapt



## Machine Learning

Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

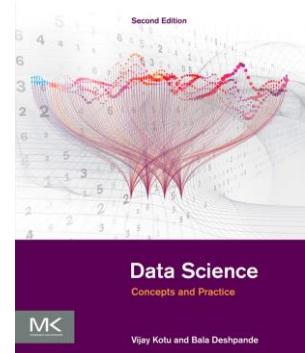
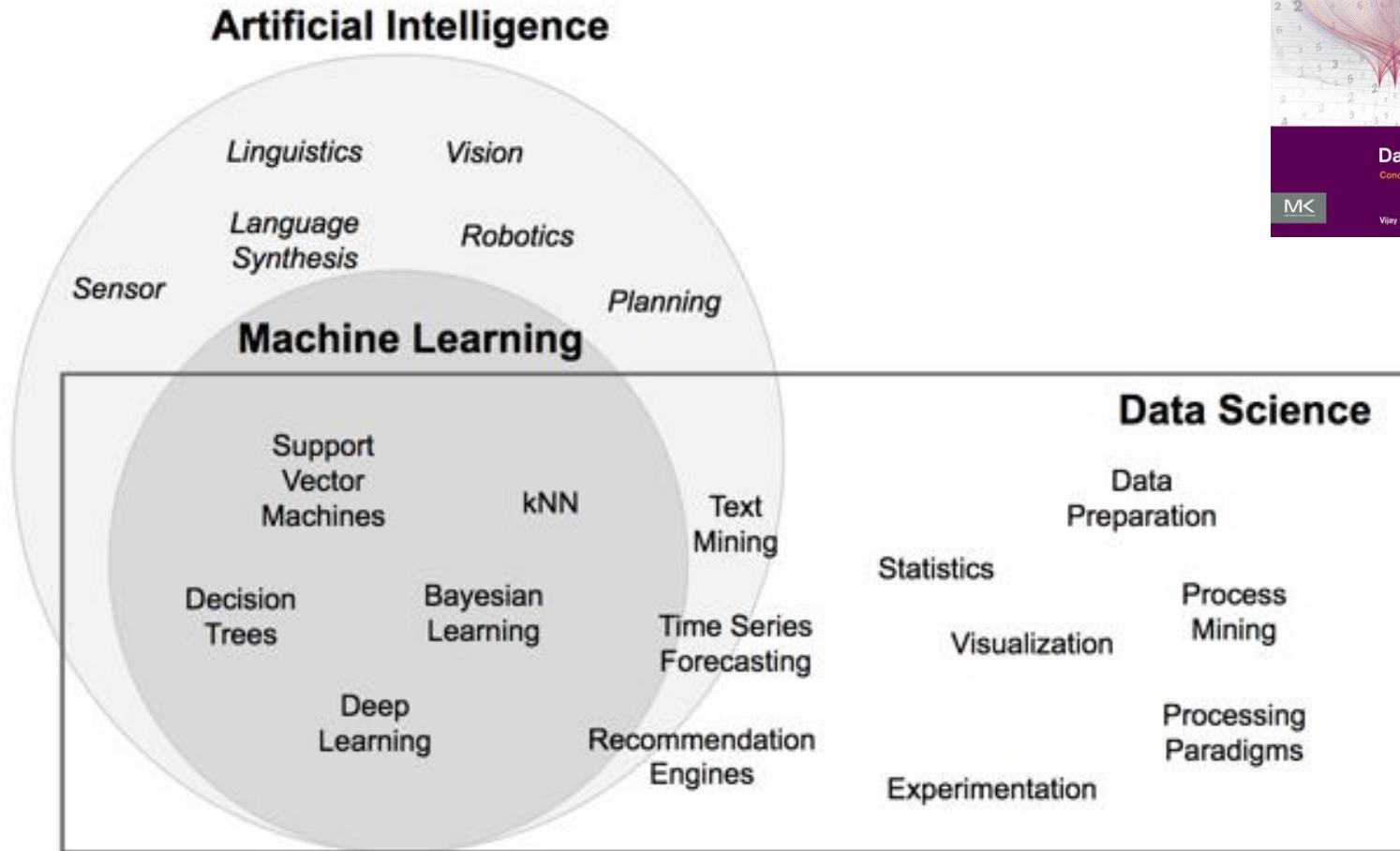


## Deep Learning

A subset of machine learning in which multilayered neural networks learn from vast amount of data.

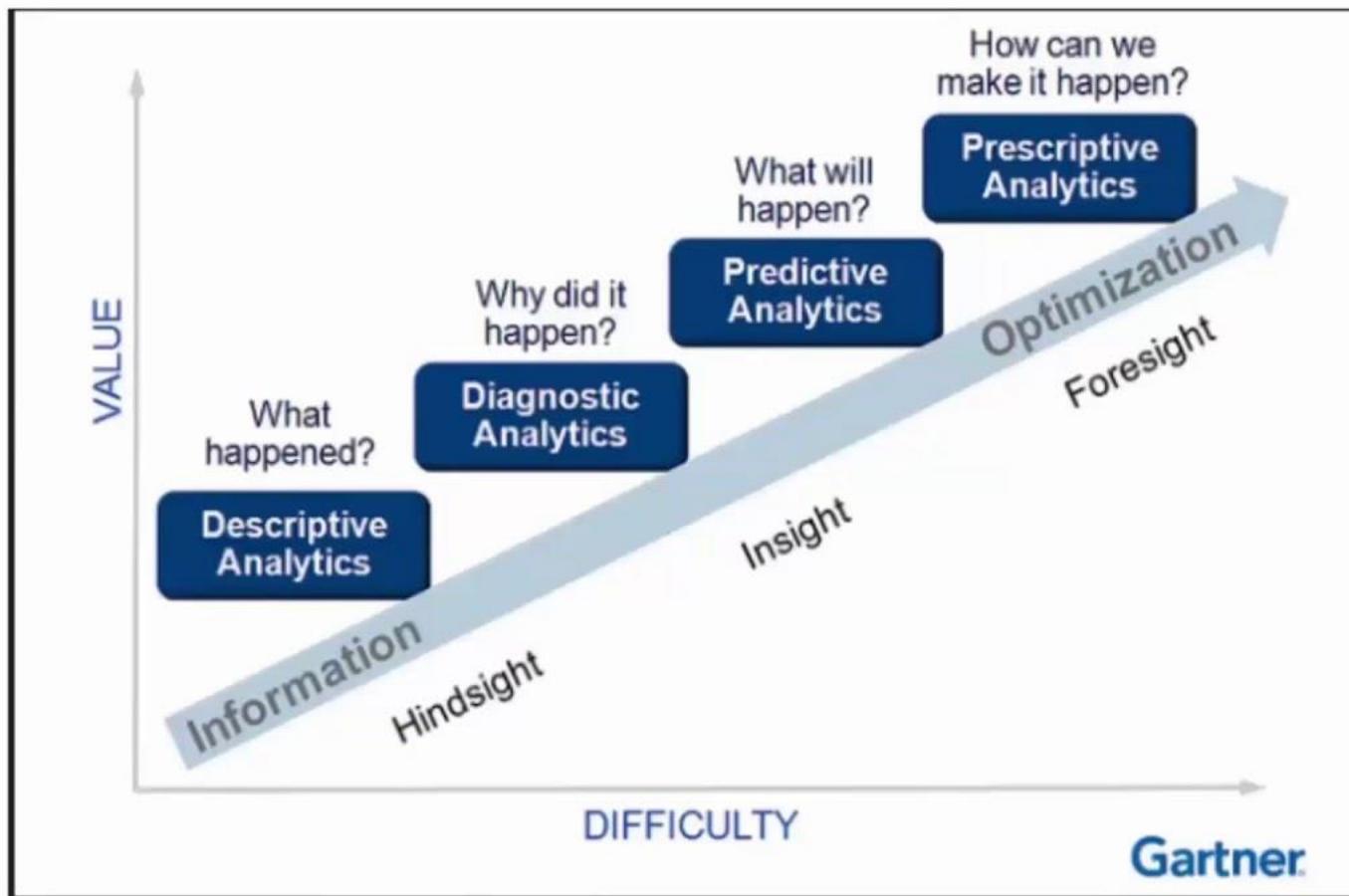


# AI vs ML vs DS





# Gartner Analytic Continuum





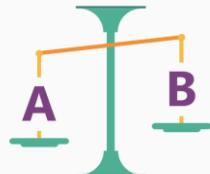
# 5 questions data science answers

**Is this weird?  
(Anomaly detection)**



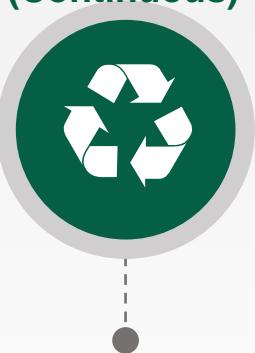
Is this pressure gauge reading normal?  
Is this message from the internet typical?

**Is this A or B?  
(Classification)  
(discrete values)**



Will this tire fail in the next 1,000 miles: Yes or no?  
Which brings in more customers: a \$5 coupon or a 25% discount?

**How many?  
How Much?  
(Regression)  
(Continuous)**



What will the temperature be next Tuesday?  
What will my fourth quarter sales be?

**How is this organized?  
(Clustering)**



Which viewers like the same types of movies?  
Which printer models fail the same way?

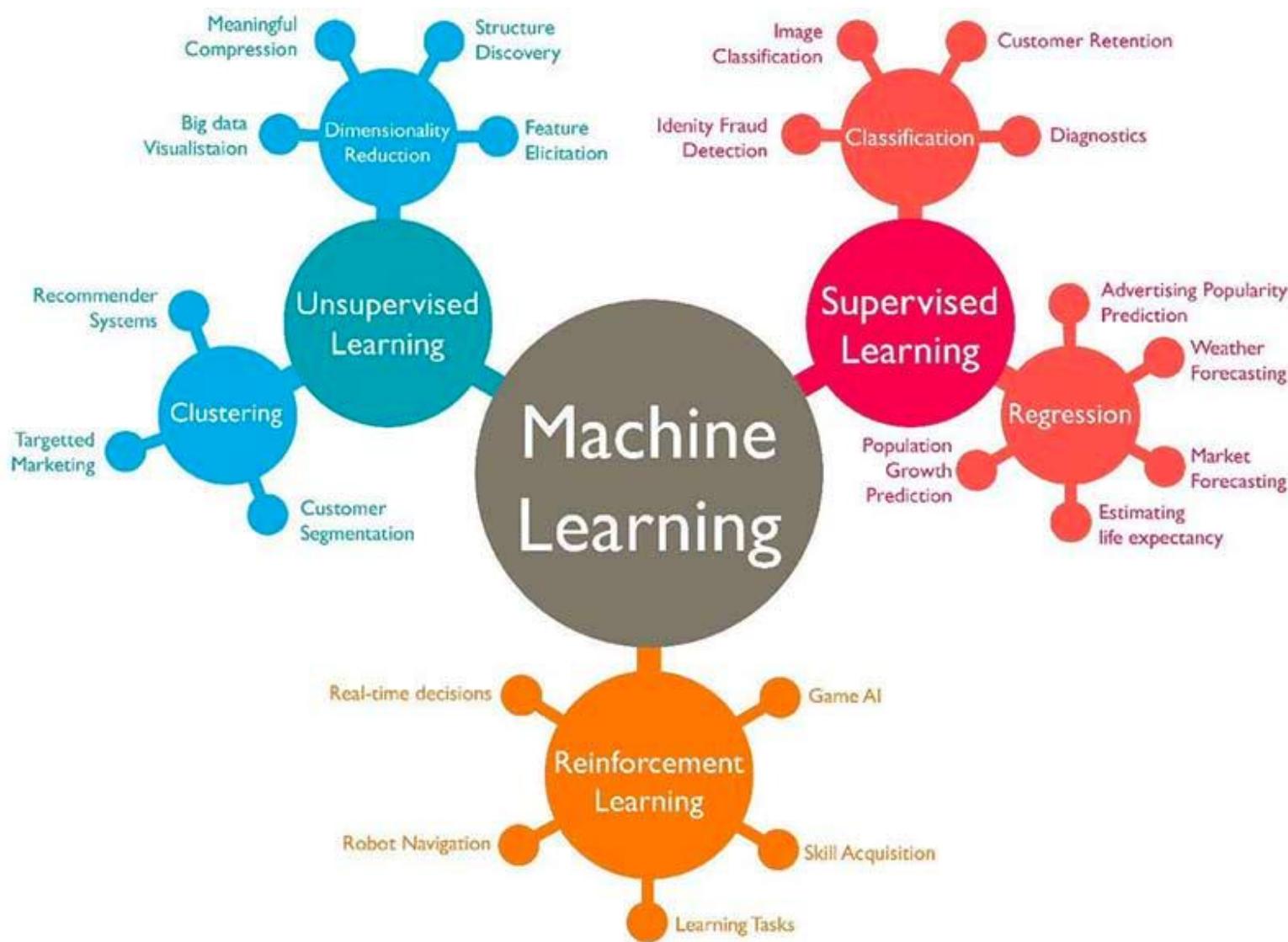
**What should I do?  
(Reinforce Learning)**



If I'm a self-driving car: At a yellow light, brake or accelerate?  
For a robot vacuum: Keep vacuuming, or go back to the charging station?



# Types of Machine Learning



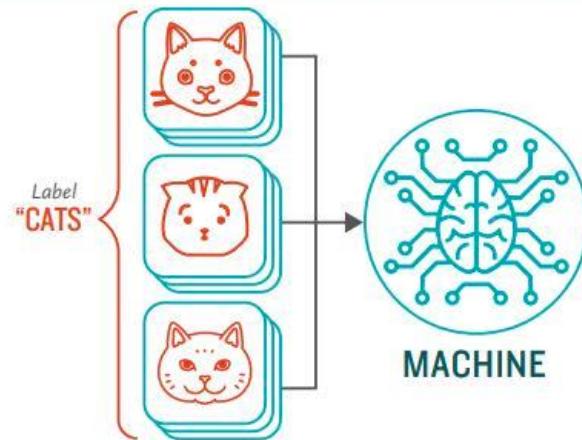


# Supervised Learning

## How **Supervised** Machine Learning Works

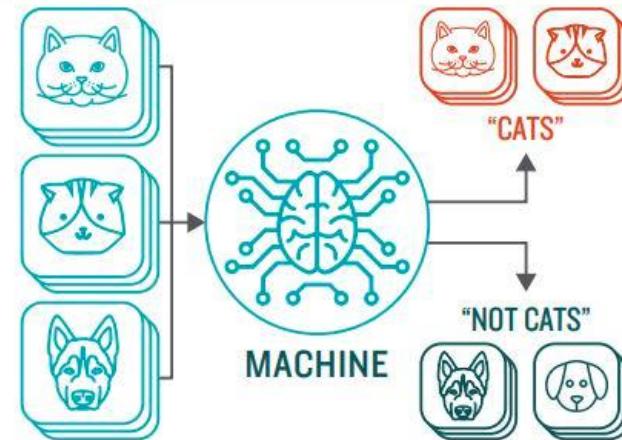
### STEP 1

Provide the machine learning algorithm categorized or "labeled" input and output data from to learn

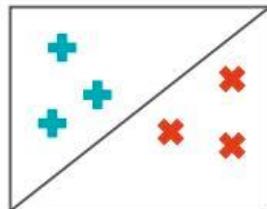


### STEP 2

Feed the machine new, unlabeled information to see if it tags new data appropriately. If not, continue refining the algorithm

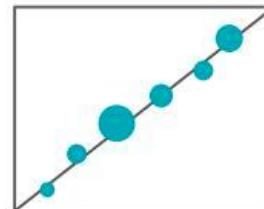


### TYPES OF PROBLEMS TO WHICH IT'S SUITED



#### CLASSIFICATION

Sorting items into categories



#### REGRESSION

Identifying real values (dollars, weight, etc.)

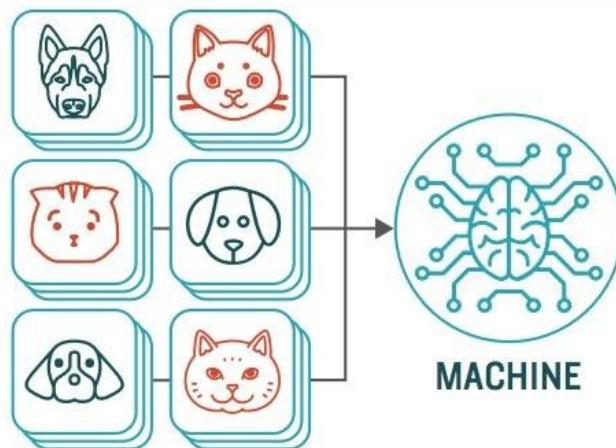


# Unsupervised Learning

## How **Unsupervised** Machine Learning Works

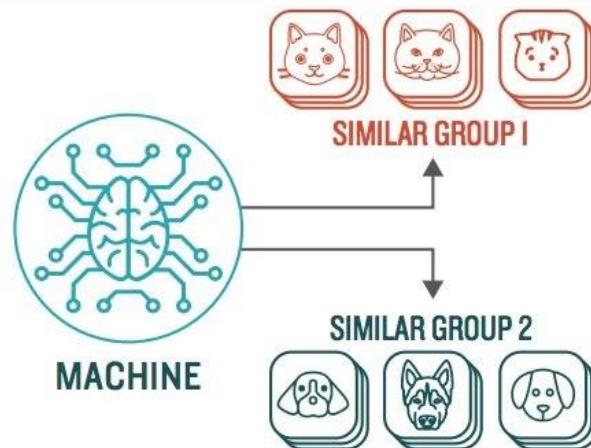
### STEP 1

Provide the machine learning algorithm uncategorized, unlabeled input data to see what patterns it finds



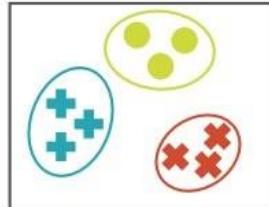
### STEP 2

Observe and learn from the patterns the machine identifies



## TYPES OF PROBLEMS TO WHICH IT'S SUITED

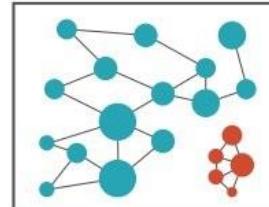
### CLUSTERING



Identifying similarities in groups

*For Example:* Are there patterns in the data to indicate certain patients will respond better to this treatment than others?

### ANOMALY DETECTION



Identifying abnormalities in data

*For Example:* Is a hacker intruding in our network?



# Machine Learning Example

- Suppose you wanted to identify fraudulent credit card transactions.
- You could define features to be:
  - Transaction time
  - Transaction amount
  - Transaction location
  - Category of purchase
- The algorithm could learn what feature combinations suggest unusual activity.





# Machine Learning Limitations

---

- Suppose you wanted to determine if an image is of a cat or a dog.
- What features would you use?
- This is where **Deep Learning** can come in.



*Dog and cat recognition*

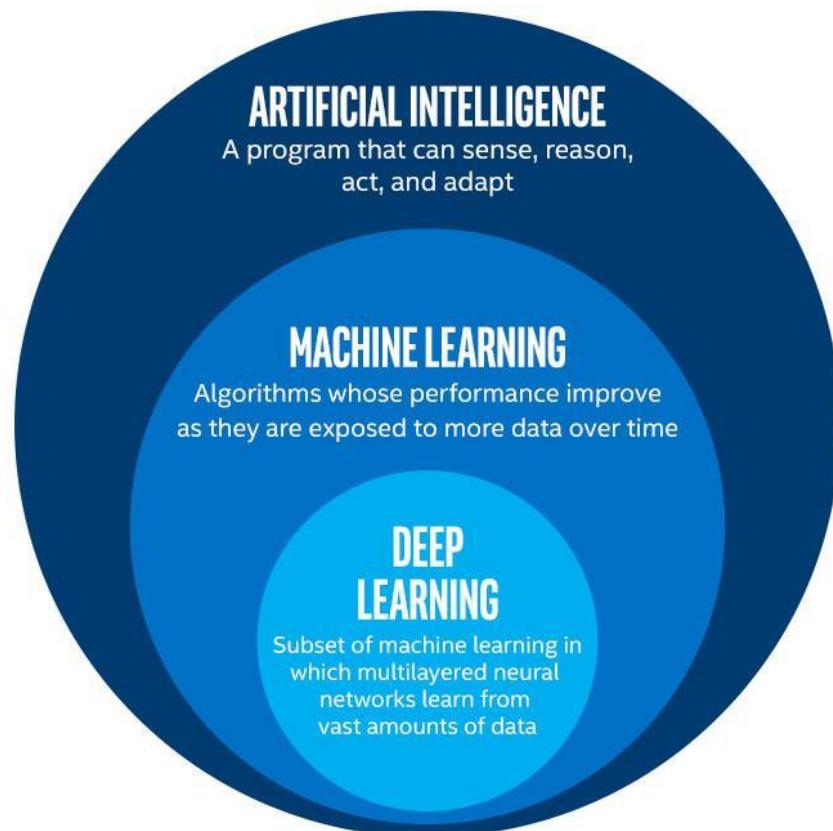


# What is deep learning?

## Deep Learning

“Machine learning that involves using very complicated models called “deep neural networks”.”  
(Intel)

*Models* determine best representation of original data; in classic machine learning, humans must do this.

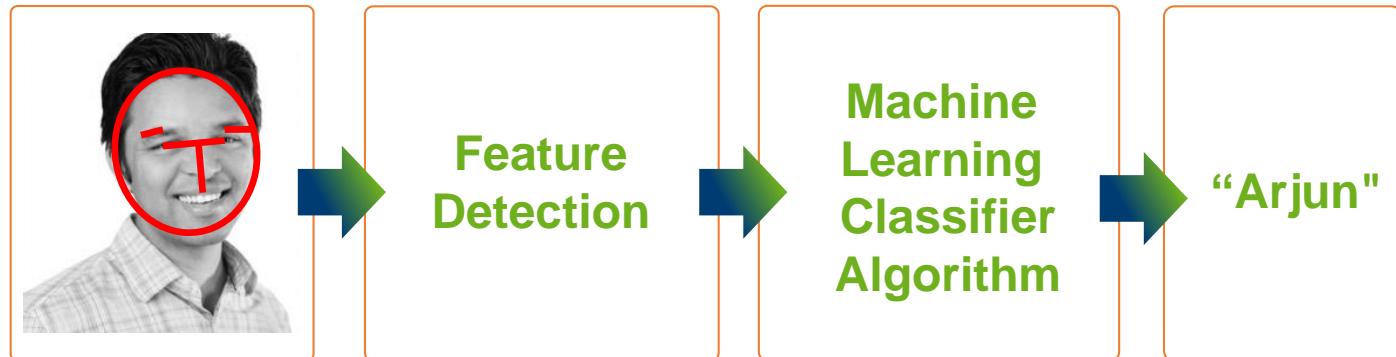




# Deep Learning Example

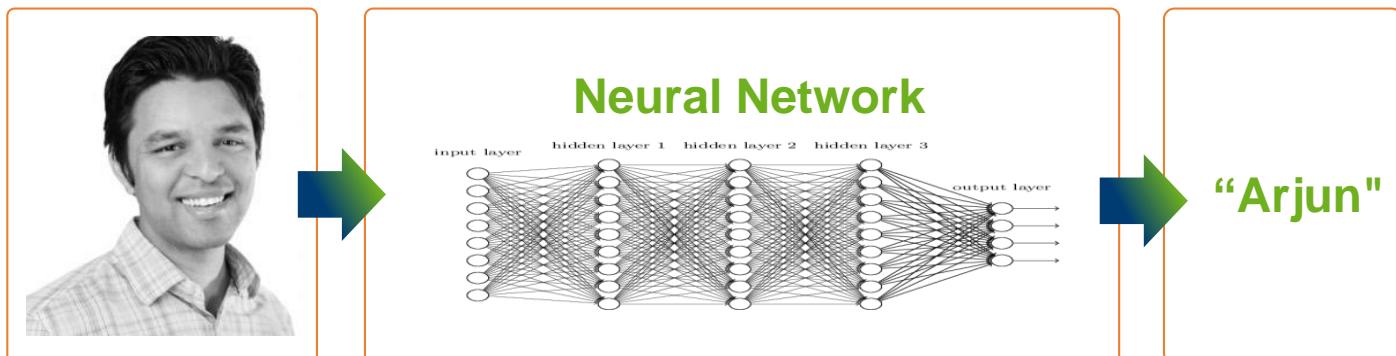
## Classic Machine Learning

Step 1: Determine features.  
Step 2: Feed them through model.



## Deep Learning

Steps 1 and 2 are combined into 1 step.





# Deep Learning in Action

[bit.ly/google\\_teachable](https://bit.ly/google_teachable)

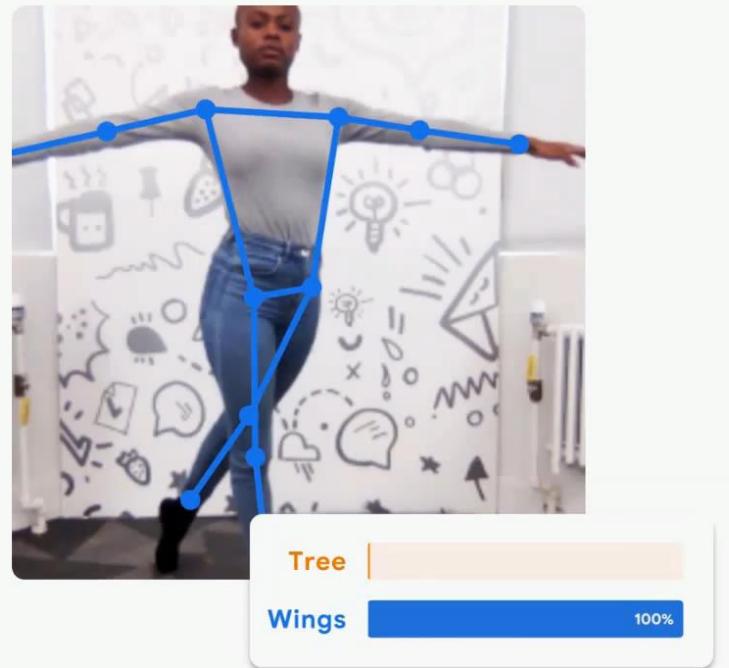
## Teachable Machine



Train a computer to recognize your own images, sounds, & poses.

A fast, easy way to create machine learning models for your sites, apps, and more – no expertise or coding required.

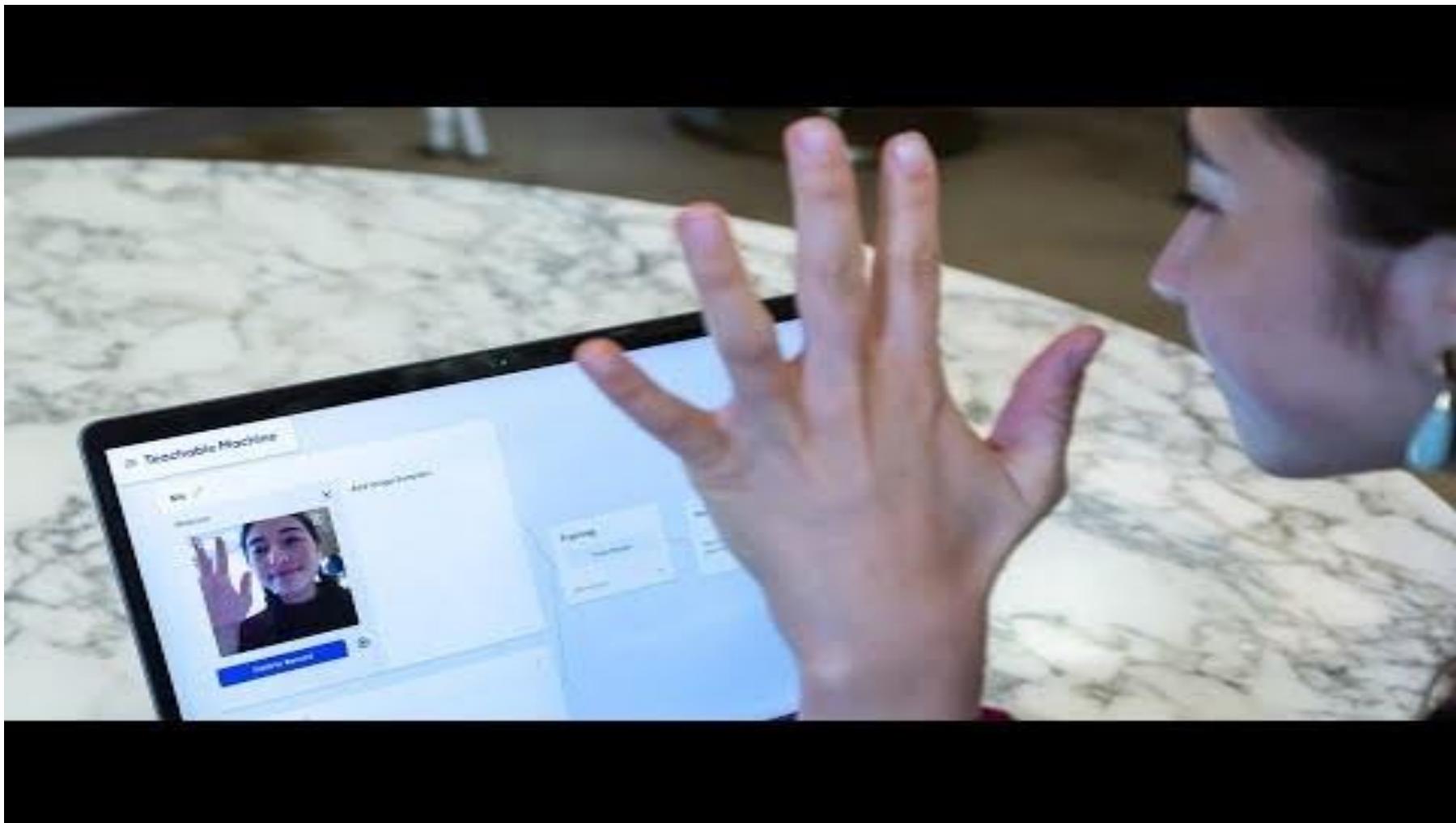
Get Started





# Teachable Machine

---



<https://teachablemachine.withgoogle.com/>



# Deep Learning Problem Types

Deep Learning can solve multiple supervised and unsupervised problems.

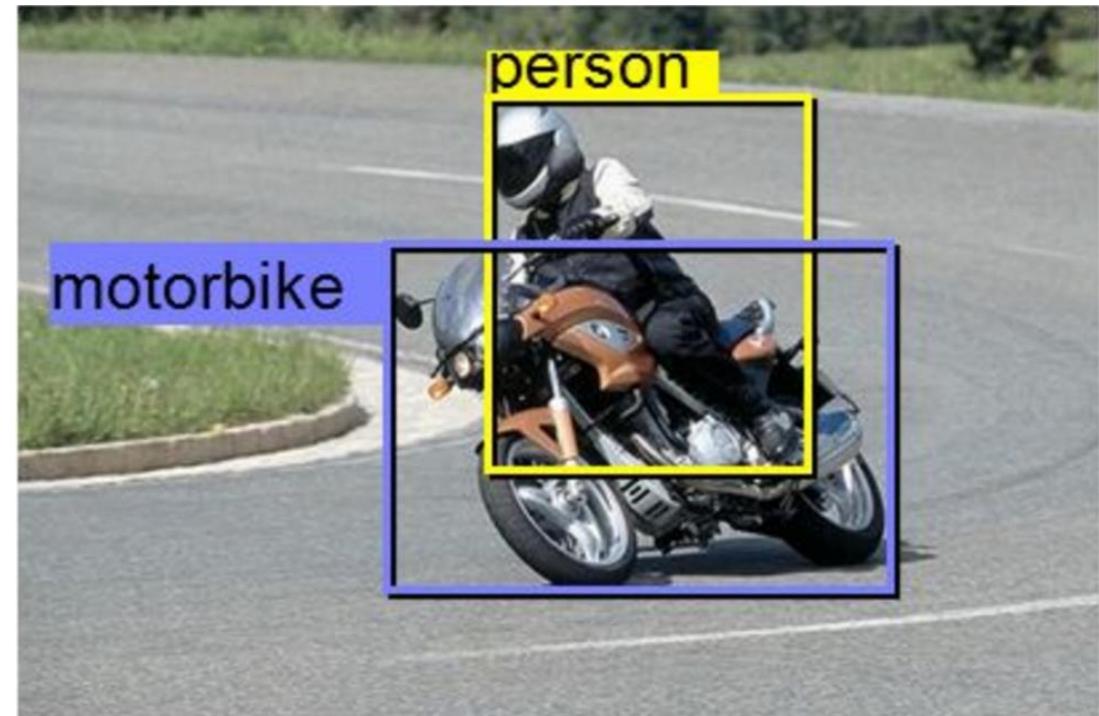
- The majority of its success has been when working with images, natural language, and audio data.
- Image classification and detection.
- Semantic segmentation.
- Natural language object retrieval.
- Speech recognition and language translation.



# Classification and Detection

Detect and label the image

- Person
- Motor Bike



<https://people.eecs.berkeley.edu/~jhoffman/talks/lsda-baylearn2014.pdf>



# Semantic Segmentation

Label every pixel



<https://people.eecs.berkeley.edu/~jhoffman/talks/lsda-baylearn2014.pdf>



# Natural Language Object Retrieval

a scene with three people query='man far right'



query='left guy'



query='cyclist'

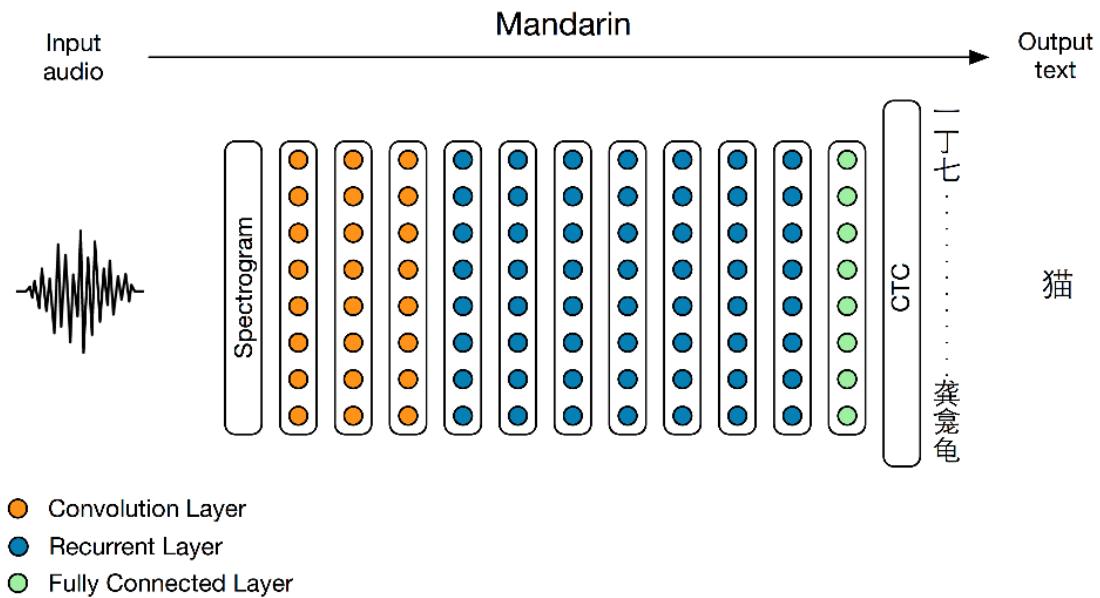


<http://arxiv.org/pdf/1511.04164v3.pdf>



# Speech Recognition and Language Translation

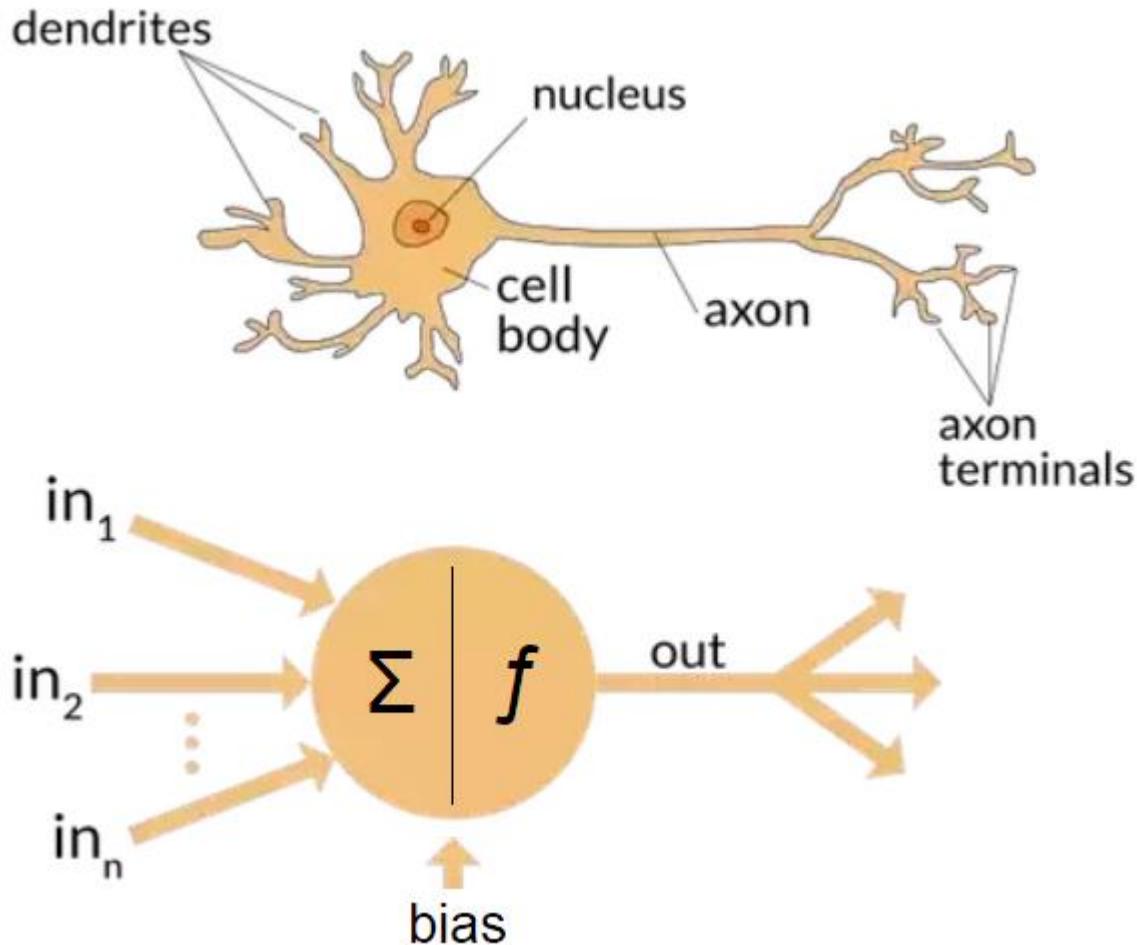
The same architecture can be used for speech recognition in English, or in Mandarin Chinese.



<http://svail.github.io/mandarin/>

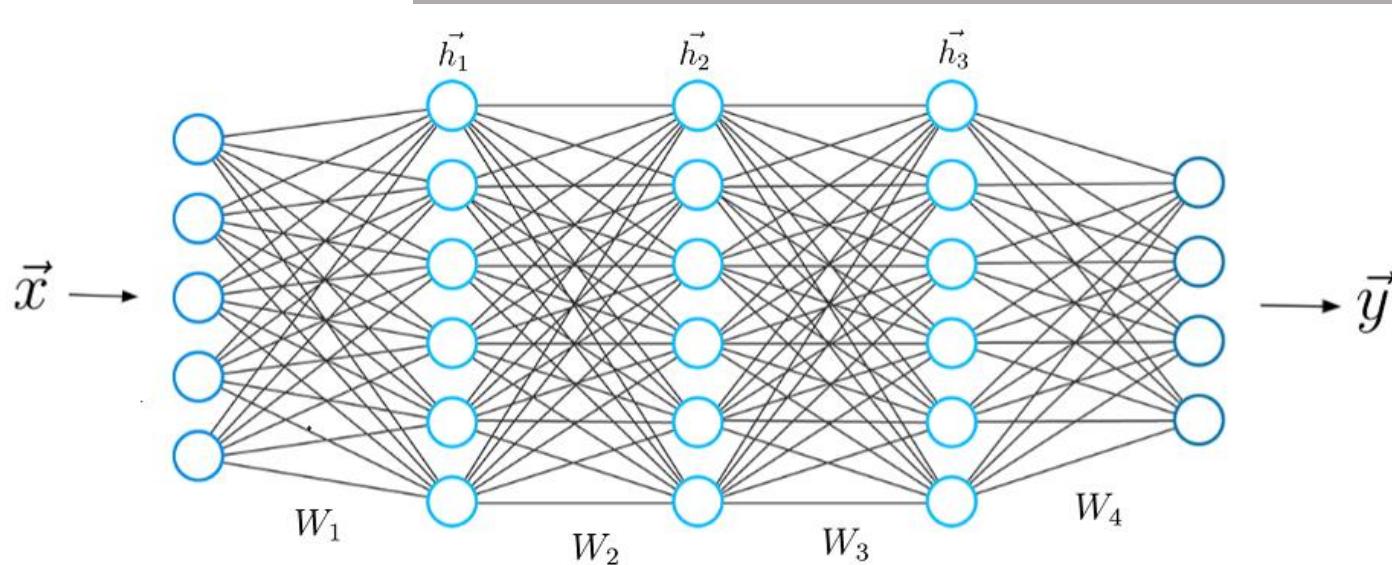


# Neural Network

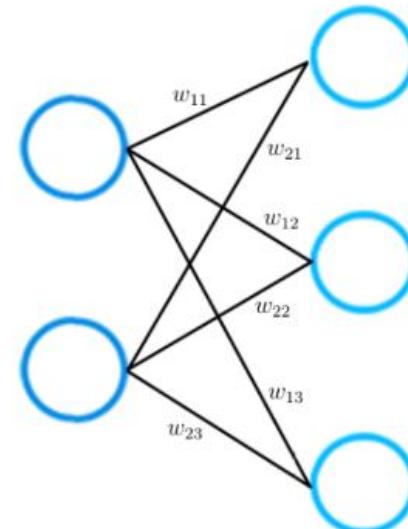




# Neural Networks



The challenge in training a neural networks is finding a set of weights the give the most accurate output.





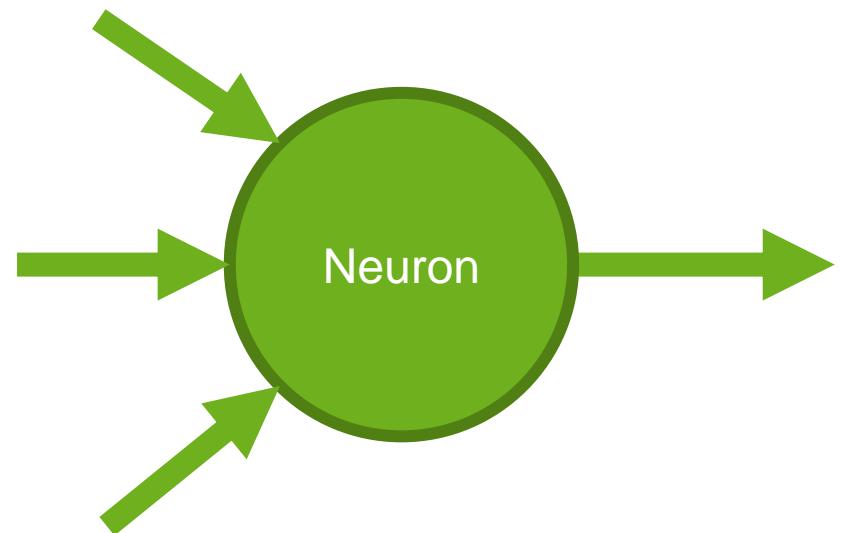
# What is neural network?



# Which model?

There are many models that represent the problem and make decisions in different ways, each with their own advantages and disadvantages.

- DL models are biologically inspired.
- The main building block is a **neuron**.

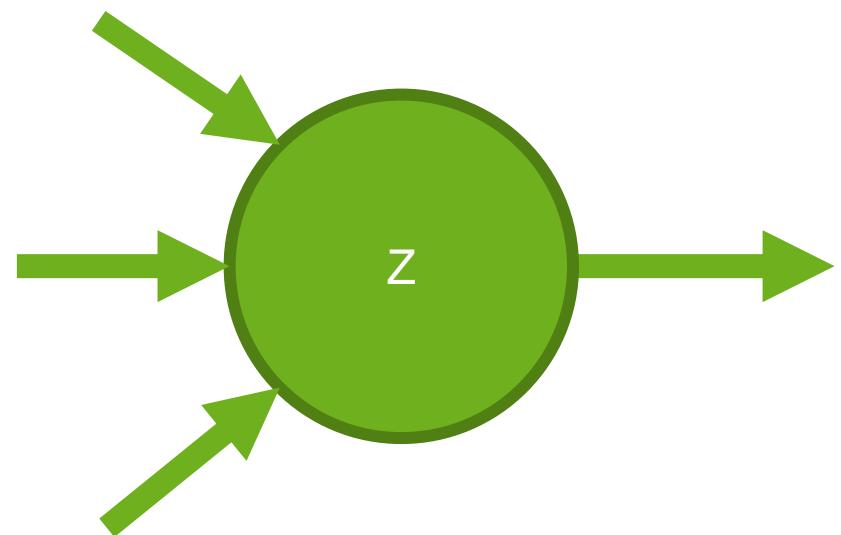




# Neuron

A neuron multiplies each feature by a **weight** and then adds these values together.

- $Z = X_1W_1 + X_2W_2 + X_3W_3$

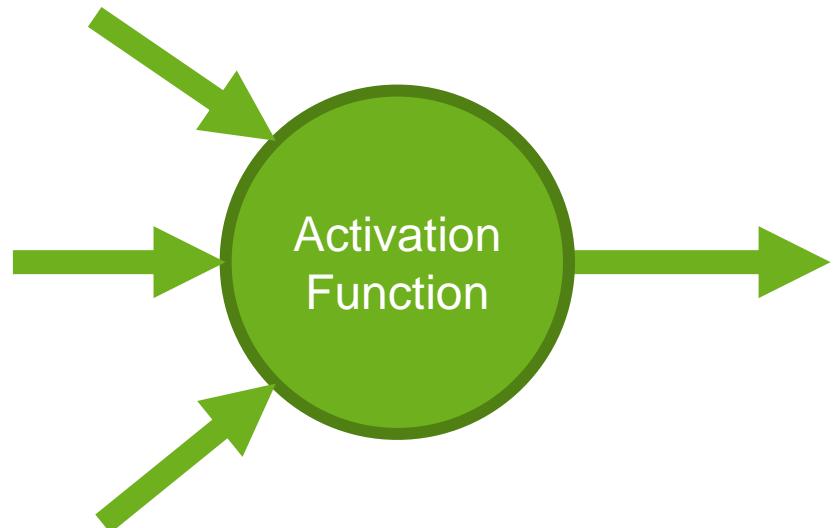




# Neuron

This value is then put through a function called the **activation function**.

- There are several activation functions that can be used.
- The output of the neuron is the output of the activation function.

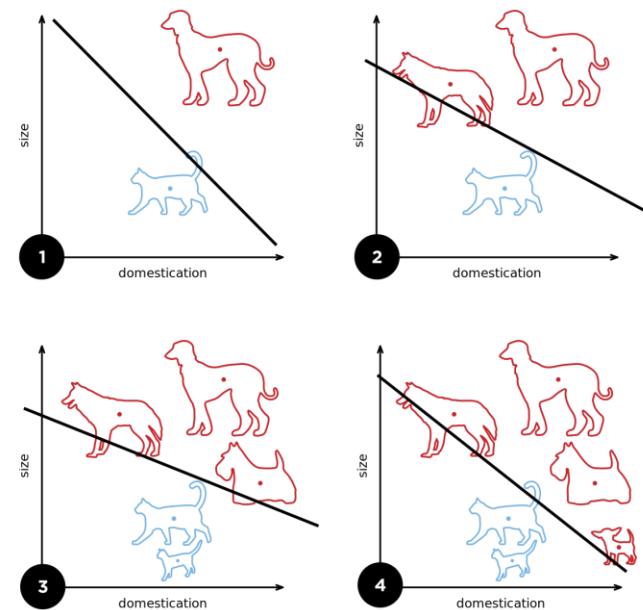




# Perceptron

A neuron with a simple activation function can solve **linearly separable** problems.

- These are problems where the different classes can be separated by a line.
- **The Perceptron:** one of the earliest neural network models that used neurons with simple activation functions.

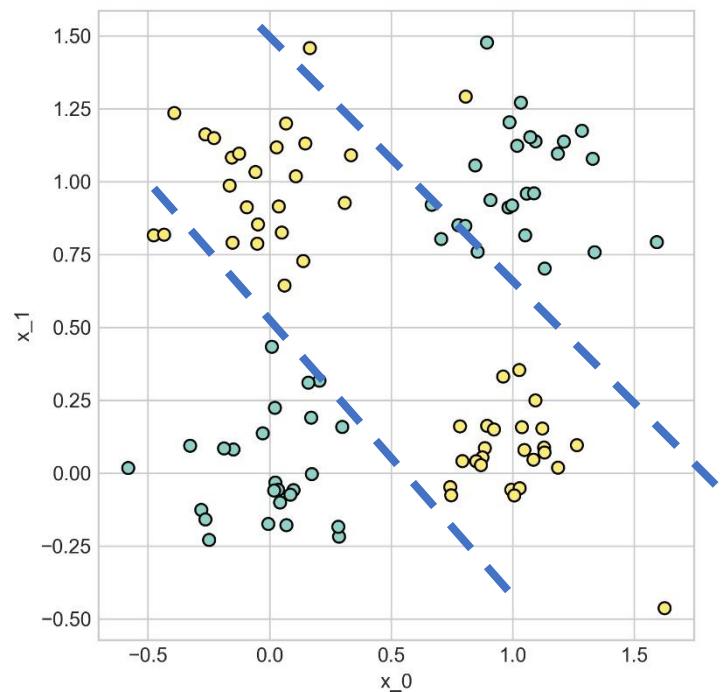




# Perceptron

Problems where the labels cannot be separated by a single line are not solvable by a single neuron.

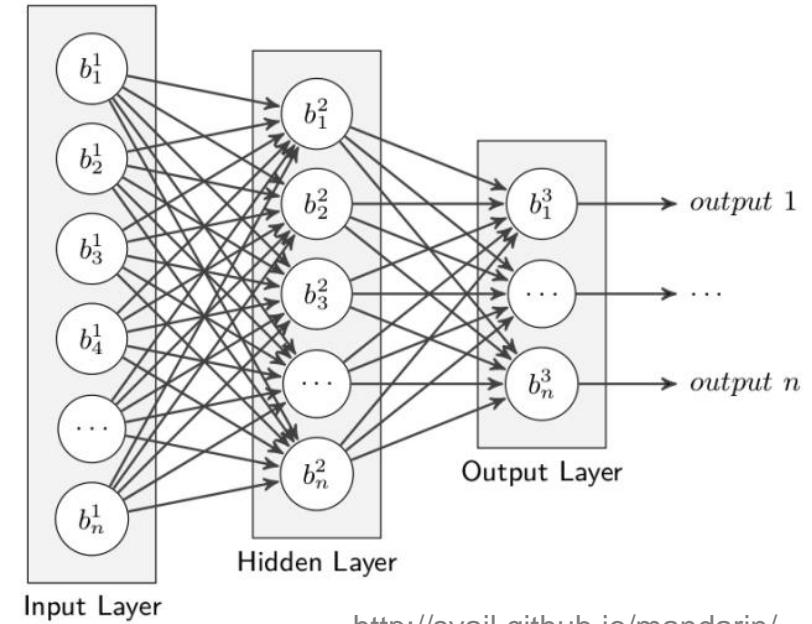
- This is a major limitation, and one of the reasons for the first AI winter, that was discussed earlier.





# Fully Connected Network

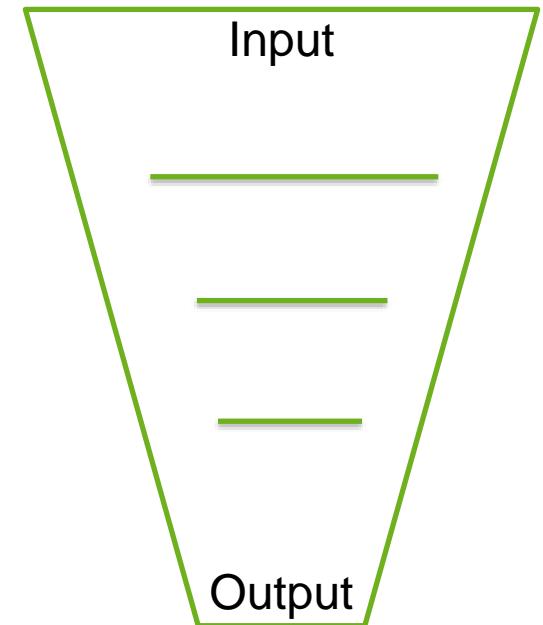
- More complicated problems can be solved by connecting multiple neurons together and using more complicated activation functions.
- Organized into **layers** of neurons.
- Each neuron is connected to every neuron in the previous layer.
- Each layer transforms the output of the previous layer and then passes it on to the next.
- Every connection has a separate weight.





# Deep Learning

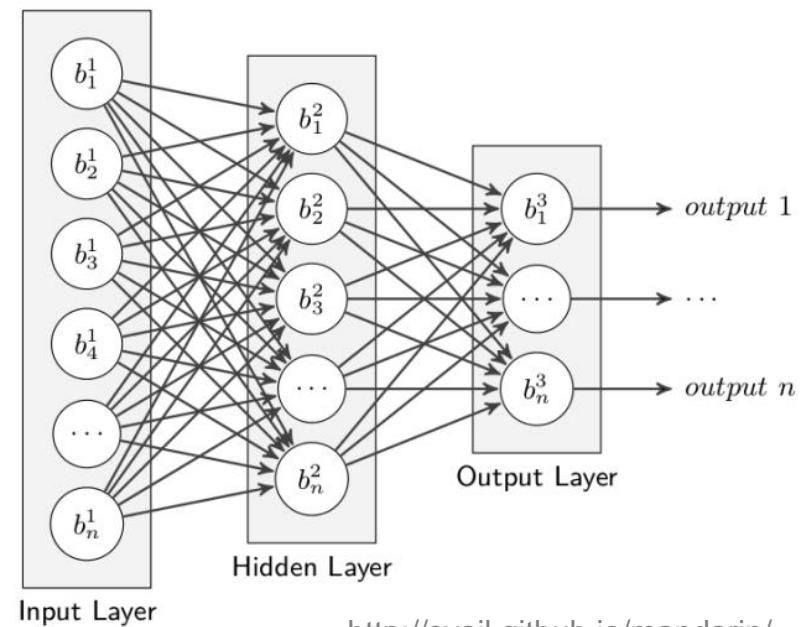
- Deep Learning refers to when many layers are used to build **deep networks**.
- State-of-the-art models use hundreds of layers.
- Deep layers tend to decrease in width.
- Successive layers transform inputs with two effects:
- **Compression**: each layer is asked to summarize the input in a way that best serves the task.
- **Extraction**: the model succeeds when each layer extracts task-relevant information.





# Steps in Building a Fully Connected Network

- To build a fully connected network a user needs to:
- Define the network architecture.
- How many layers and neurons?
- Define what activation function to use for each neuron.
- Define an evaluation metric.
- The values for the weights are learned during model training.



<http://svail.github.io/mandarin/>



# Evaluation Metric

The metric used will depend on the problem being solved. Some examples include:

- Regression
  - Mean Squared Error
- Classification
  - Categorical Cross-Entropy
- Multi-Label classification
  - Binary Cross-Entropy



# Fully Connected Network Problems

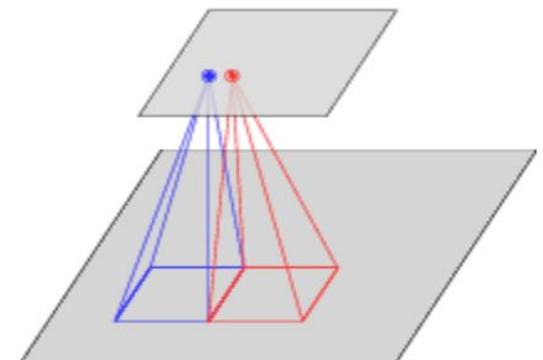
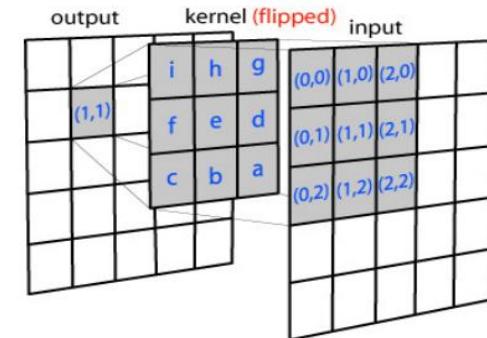
Not optimal for detecting features.

- Computationally intensive – heavy memory usage.



# Convolutional Neural Network

- **Convolutional neural networks** reduce the required computation and are good for detecting features.
- Each neuron is connected to a small set of nearby neurons in the previous layer.
- The same set of weights are used for each neuron.
- Ideal for spatial feature recognition.
  - Example: image recognition
- Cheaper on resources due to fewer connections.

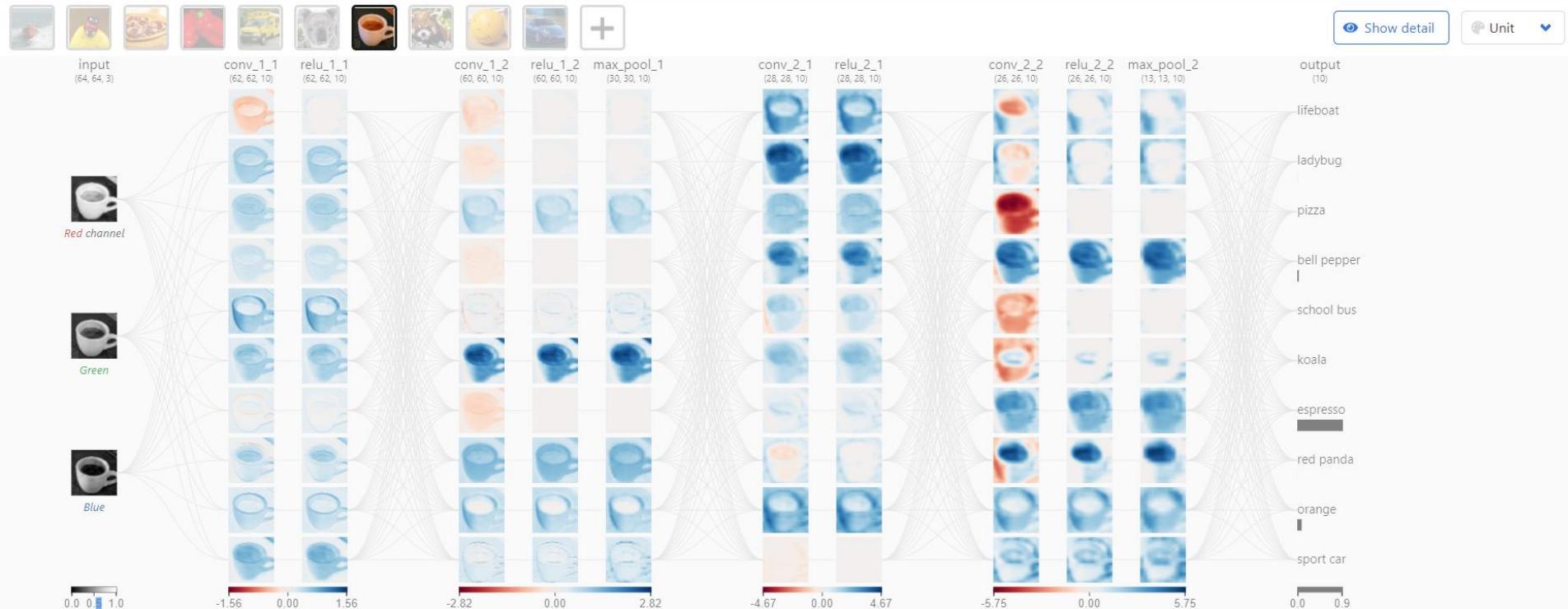


<http://svail.github.io/mandarin/>



# What is a Convolutional Neural Network?

**CNN EXPLAINER** Learn Convolutional Neural Network (CNN) in your browser!



<https://poloclub.github.io/cnn-explainer/>





# Convolutions as Feature Detectors

**Convolutions** can be thought of as “local feature detectors”.

Vertical Line Detector

-1	1	-1
-1	1	-1
-1	1	-1

Horizontal Line Detector

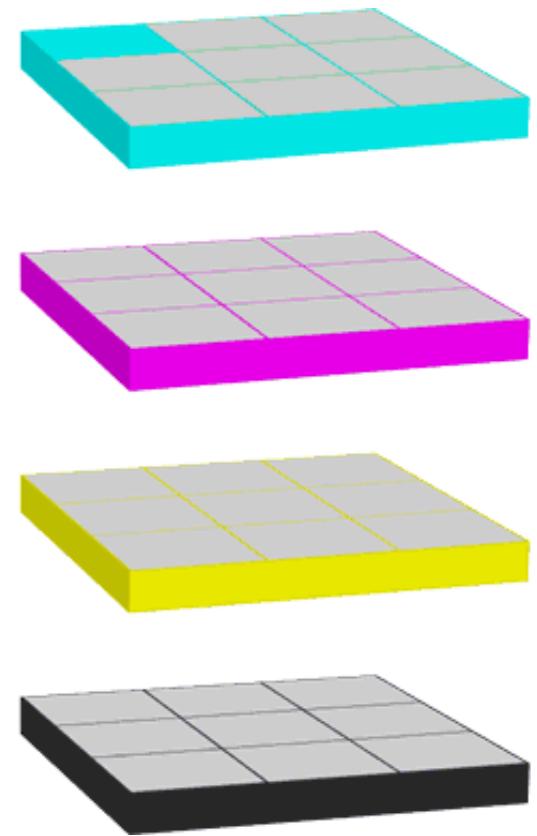
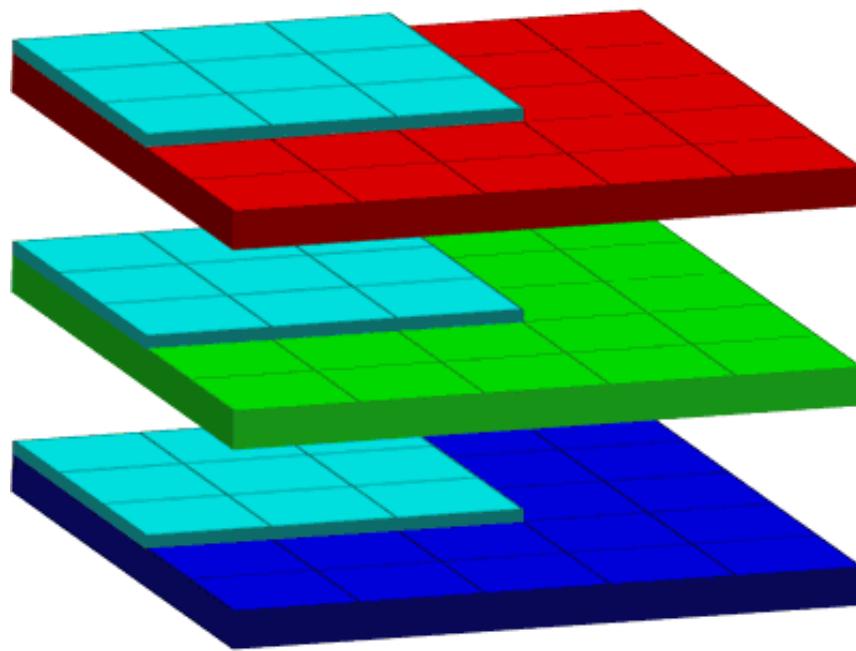
-1	-1	-1
1	1	1
-1	-1	-1

Corner Detector

-1	-1	-1
-1	1	1
-1	1	1

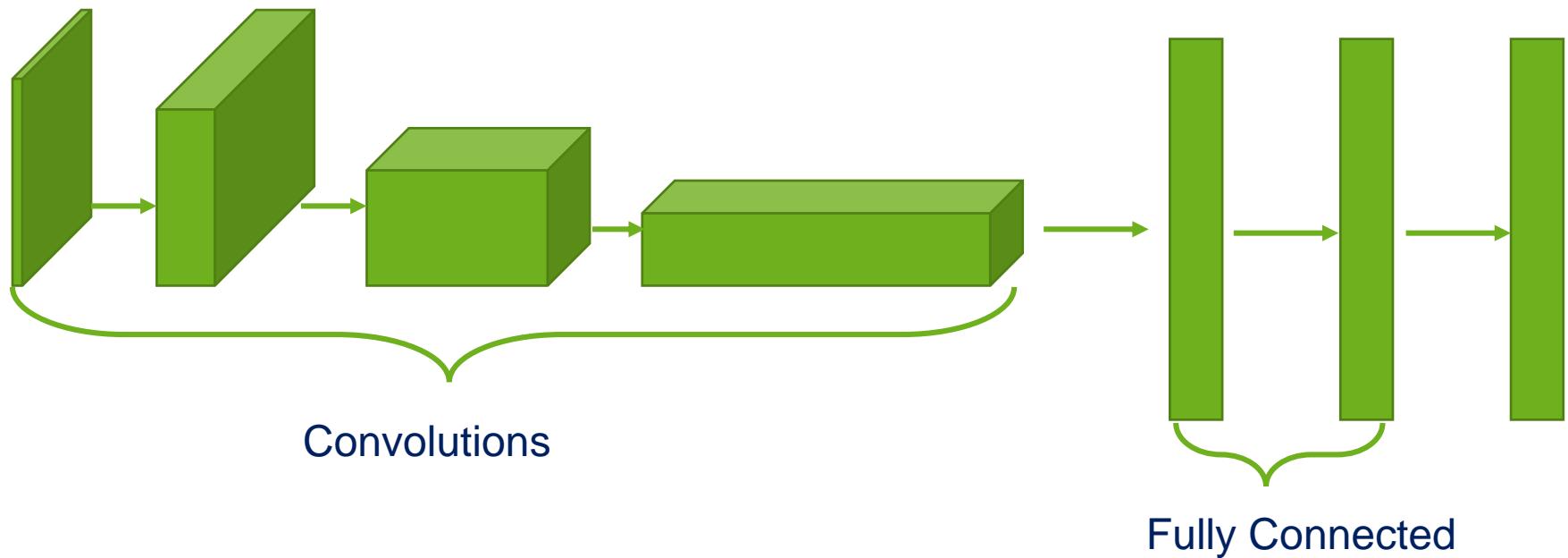


# Convolutions





# Convolutional Neural Network





# Common Architectures

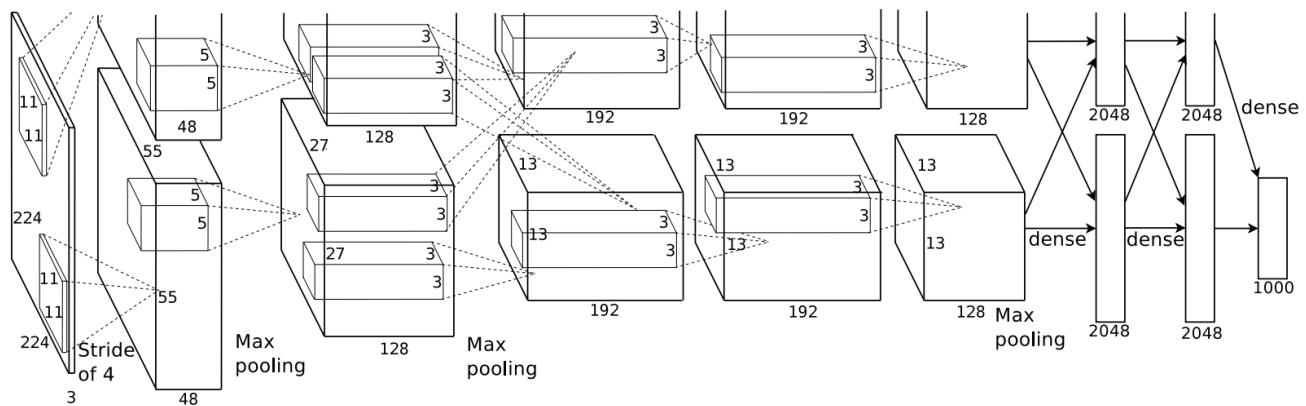
---

- AlexNet
- VGG
- Inception
- MobileNets



# AlexNet

- Created in 2012 for the ImageNet Large Scale Visual Recognition Challenge (ILSVRC)
- Task: predict the correct label from among 1000 classes
- Dataset: around 1.2 million images
- Considered the “flash point” for modern deep learning
- Demolished the competition.
- Top 5 error rate of 15.4%
- Next best: 26.2%





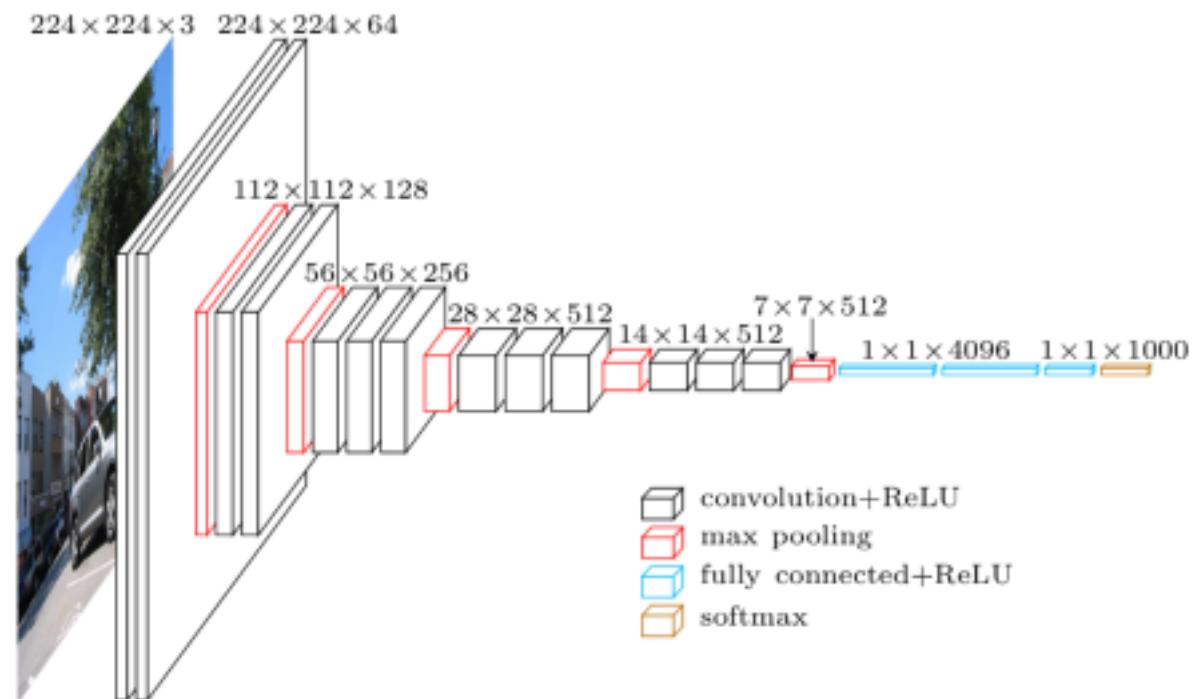
# VGG

- Simplify Network Structure
- Avoid Manual Choices of Convolution Size
- Very Deep Network with 3x3 Convolutions
- These “effectively” give rise to larger convolutions

Reference:

*Very Deep Convolutional Networks for Large-Scale Image Recognition*

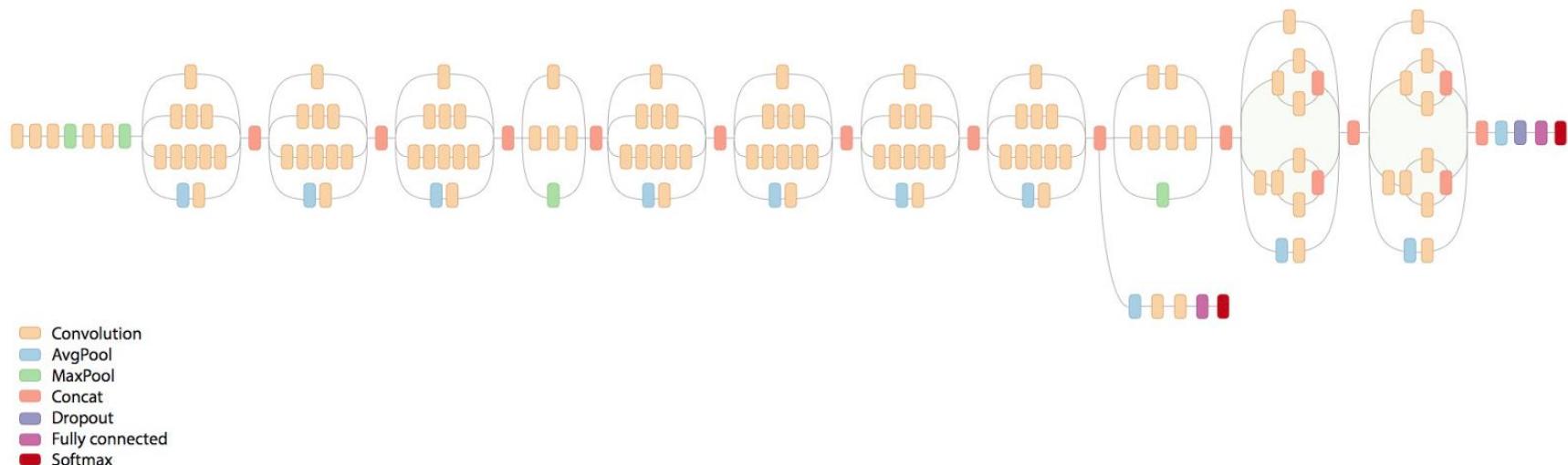
Karen Simonyan and Andrew Zisserman, 2014





# Inception

- Szegedy et al 2014
- Idea: network would want to use different receptive fields
- Solution: Turn each layer into branches of convolutions
- Each branch handles smaller portion of workload
- Concatenate different branches at the end





# MobileNets

- Efficient models for mobile and embedded vision applications.



MobileNet models can be applied to various recognition tasks for efficient device intelligence.



# Pre-trained CNN models

---

- Models for image classification with weights trained on **ImageNet**:
  - Xception
  - VGG16
  - VGG19
  - ResNet, ResNetV2
  - InceptionV3
  - InceptionResNetV2
  - MobileNet
  - MobileNetV2
  - DenseNet
  - NASNet
  - EfficientNet



# Recurrent Neural Network

## Issue: Variable length sequences of words

- With images, we forced them into a specific input dimension
- Not obvious how to do this with text.
- For example, classify tweets as positive, negative, or neutral.
- Tweets can have a variable number of words.
- What to do?



# Recurrent Neural Network

## Issue: Ordering of words is important

- Want to do better than “bag of words” implementations
- Ideally, each word is processed or understood in the appropriate context.
- Need to have some notion of “context”.
- Words should be handled differently depending on “context”
- Also, each word should update the context.



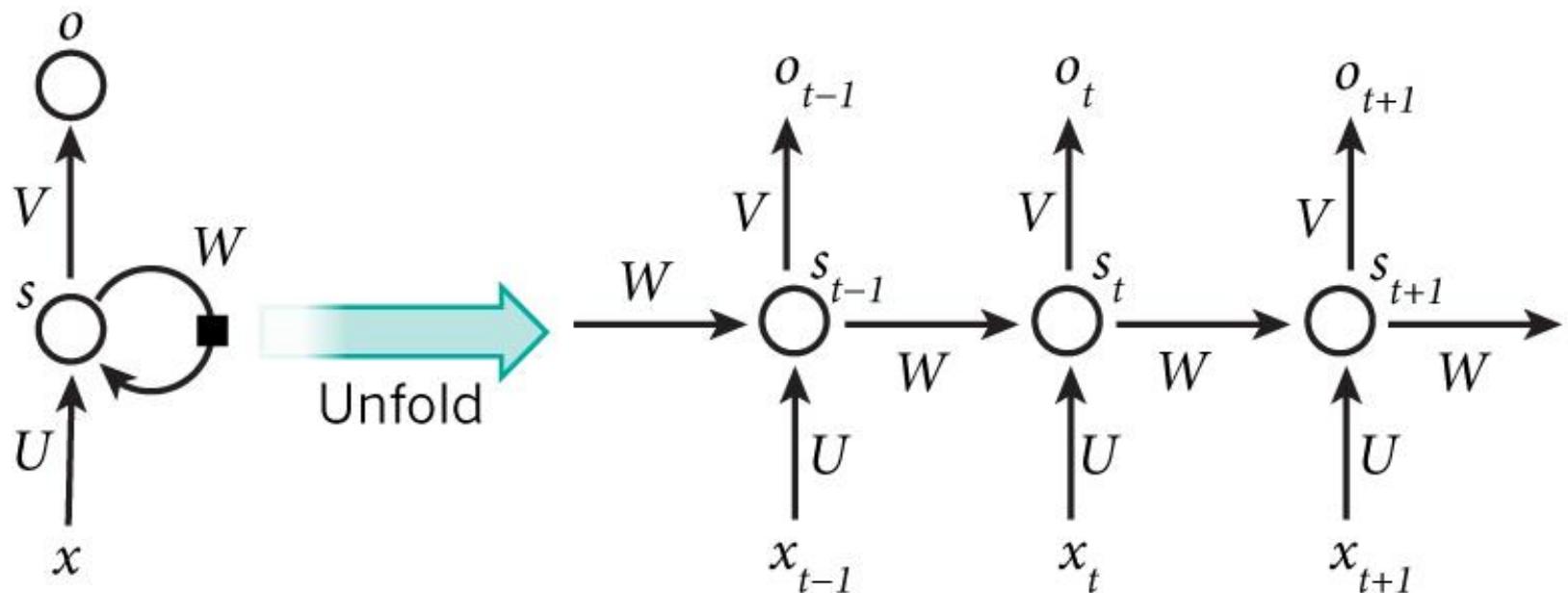
# Recurrent Neural Network

Idea: Use the notion of “recurrence”

- Input words one by one
- Network outputs two things:
  - Prediction: What would be the prediction if the sequence ended with that word
  - State: Summary of everything that happened in the past
- This way, can handle variable lengths of text
- The response to a word depends on the words that preceded it.



# Recurrent Neural Network





# Recurrent Neural Network

- For text/words as application.
- But, RNNs can be used for other sequential data
  - Time-Series Data
  - Speech Recognition
  - Sensor Data
  - Genome Sequences
- Nature of state transition means it is hard to keep information from distant past in current memory without reinforcement.
- **In real life, implementing RNN is hard. A more practical implementation is called Long Short-Term Memory (LSTMs), which have a more complex mechanism for updating the state.**



# What is a CNN?

---



# Reinforcement Learning



Photo: ST



# Reinforcement Learning

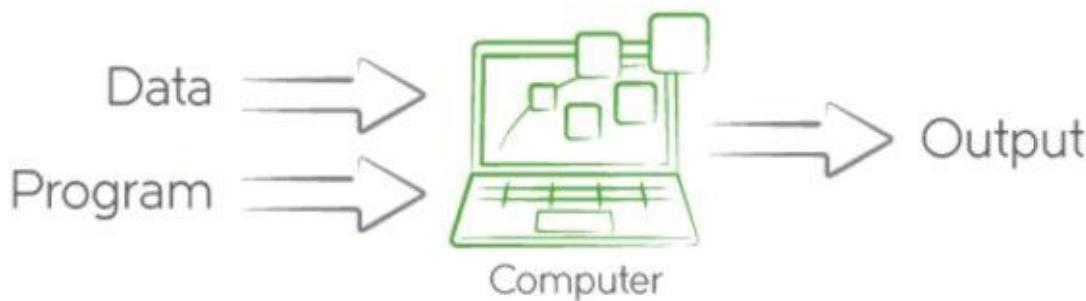




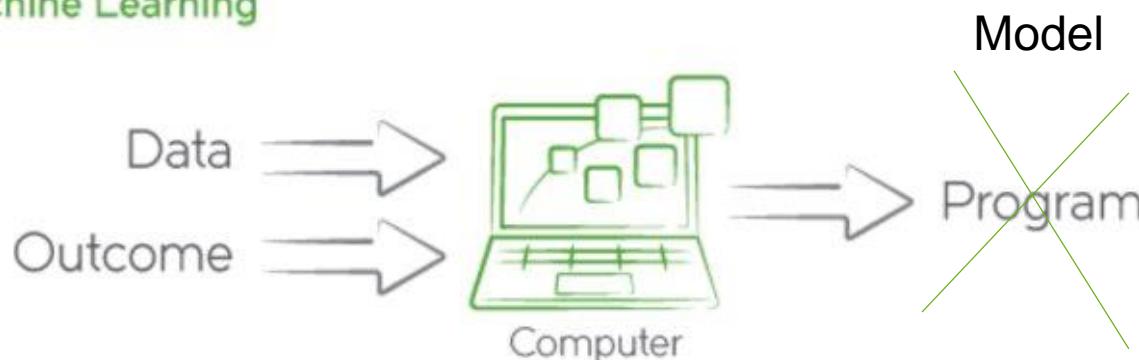


# Traditional Programming vs Machine Learning

## Traditional Programming



## Machine Learning





# 60 mins Lunch Break

---

**Some interesting videos**

<https://www.youtube.com/watch?v=bmNaLtC6vkU>

[https://www.youtube.com/watch?v=Nnf8P5A\\_saE](https://www.youtube.com/watch?v=Nnf8P5A_saE)

LUNCH BREAK





# AI Software

As datasets get bigger the **need for optimized software becomes increasingly important.**

- The computation required increases with the size of the dataset.
- Software needs to be optimized for the underlying hardware to take full advantage of faster computers.
- The software and hardware need to be optimized for specific mathematical operations for optimal performance.



# AI Software

It is usually inefficient for AI developers to write software to manage and analyze this data themselves.

- Developing software optimized for hardware and mathematical operations is time consuming.
- As methods become increasingly sophisticated the code for mathematics become more error prone.



# AI Developer

An AI developer needs to **leverage existing code** so they can focus on the big picture and overall system framework.

- Use code that's optimized for the underlying hardware since AI tasks require a large amount of computation to complete.
- Simplify model development and training by providing high-level primitives for complex and error-prone mathematical transformations.
- Understand and use algorithms by stringing together API calls.
- Take advantage of software libraries and frameworks.



# AI Frameworks

A **software framework** provides generic functionality that can act as a skeleton architecture to accomplish a particular task.

- A framework **dictates the flow of control** and defines the overall nature of the program where common design patterns can be reused.
- Frameworks **can be extended** by the users to provide specific functionality and customizations.
- Frameworks provide **a standard way to build** and deploy applications.
- Multiple frameworks can use the same underlying libraries.



# Deep Learning Frameworks

Deep Learning frameworks vary in their level of functionality.

- Some allow you to define a neural network of arbitrary complexity from the most basic building blocks
- Others act as drivers or wrappers aimed at boosting developer productivity but are limited in their functionality due to the higher level of abstraction.



# AI frameworks

---

## Frameworks



Caffe

theano

PYTORCH

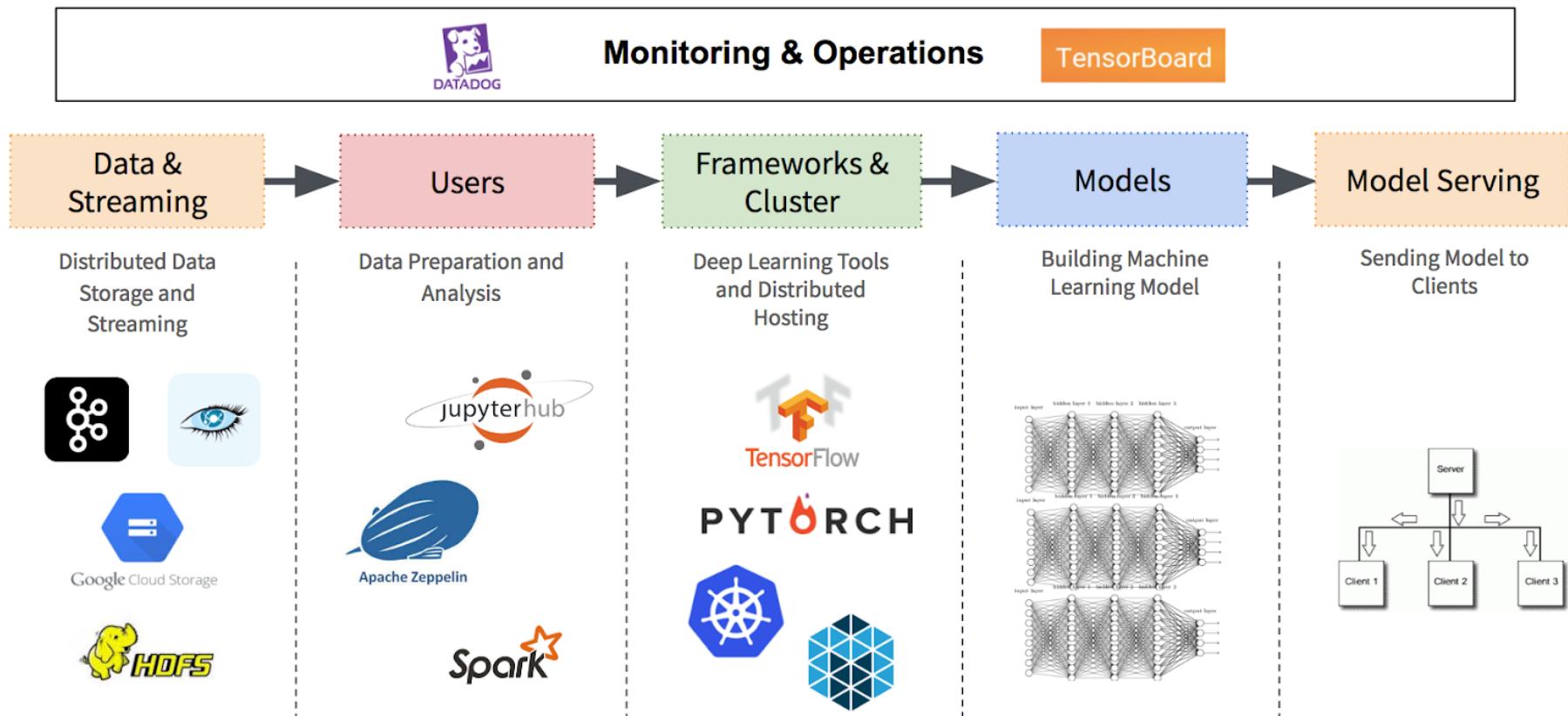


++  
Caffe2





# Deep Learning Pipeline





# Tensorflow

TensorFlow\*: Python\* based DL framework designed for ease of use and extensibility on modern deep neural networks.

- Open-sourced by Google in November 2015.
- As of May 2017, it now integrates optimizations for Intel® Xeon® processors.
- According to technology site KDNuggets\*, as of 2018 TensorFlow is the most popular deep learning framework
- Based on defining static computation graphs and then having multidimensional arrays through the graph.





# Tensorflow

TensorFlow\* is based on the idea of defining static computational graphs and flowing data through them.

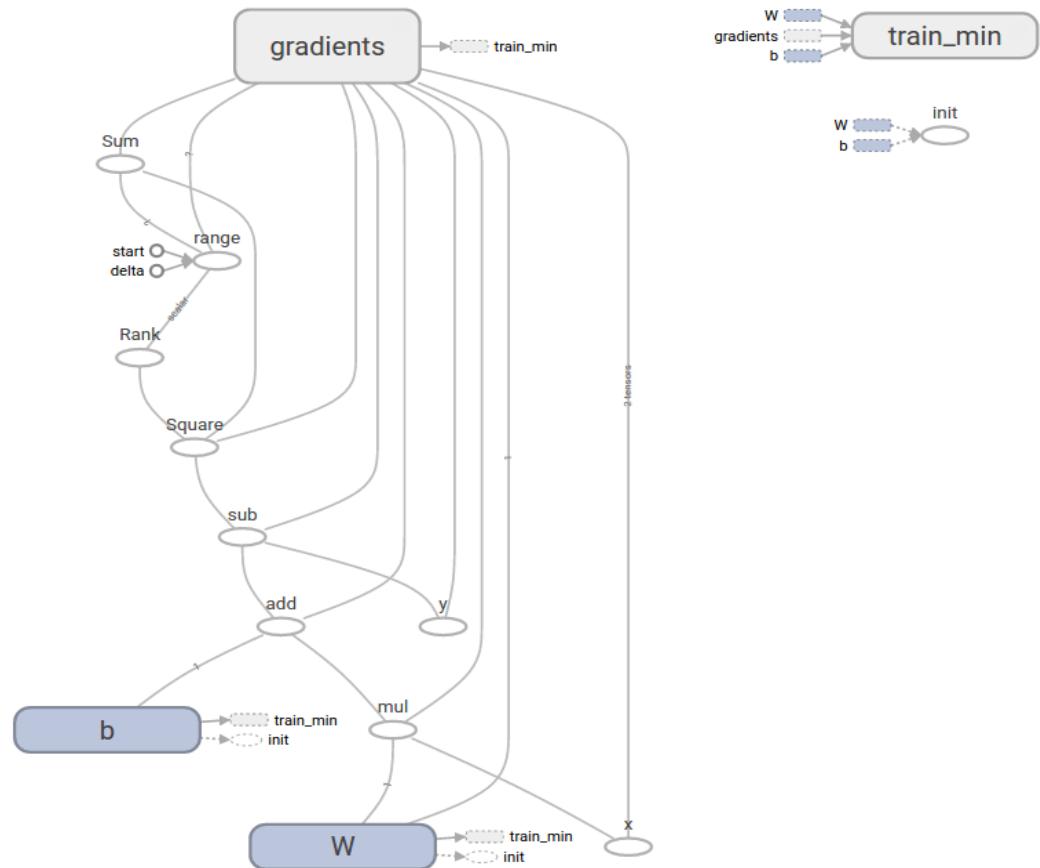
- Edges represent numerical data flowing through the graph.
- Nodes represent computations.
- Data is represented as tensors that are typed multidimensional arrays.
- These can be used to represent words, images, or any other data flowing through the network.
- TensorFlow uses “optimizers”, such as gradient descent, Adam, and RMSProp, to train neural networks.





# Tensorflow

Computational graph  
for linear regression.  
Source: TensorFlow\*





# Caffe

Caffe\* is a deep learning framework written in C++.

- Developed at the University of California Berkeley in 2014.
- Designed to run fast on GPUs, the most popular DL solution at that time.

# Caffe



# Caffe2

Caffe2\* is an open source DL framework announced by Facebook in April 2017 with new features.

- Deployed at Facebook to help researchers train large machine learning models and deliver AI on mobile devices.
- Built with expression, speed, and modularity in mind.



**Caffe2**



# Theano

Theano\* is a Python\* numerical computation library.

- Developed at the University of Montreal.
- Designed to run fast on GPUs.
- Improved performance on Intel® Xeon® and Intel® Xeon Phi™ processors with this fork of the popular Python library.
- Announced in September 2017 that major development will stop.





# MXNet

MXNet\* is an open-source, deep learning framework.

- Apache\* project originally developed within Carnegie Mellon University.
- Includes built-in support for the Intel® Math Kernel Library (Intel® MKL).
- Now includes Intel, Microsoft, and multiple universities as contributors.
- Characterized by nearly linear scaling with the number of GPUs used (doubling GPUs leads to nearly double the speed).
- Supports both imperative and symbolic programming.





# PyTorch

---

- Python wrapper over Torch (C++ library) released in Jan 2017
- Also stores data and variables as Tensors
- Developed by Facebook and other companies
- Deep Learning operations are done outside of P
  - Graph based
  - Nodes are operations
  - Edges are multi-dimensional arrays called tensors

PYTORCH



# neon™ Framework

neon™ is a deep learning solution optimized for Intel® architecture.

- Nervana™ Systems, founded in 2014, open-sourced neon™ in 2015.
- Nervana Systems joined Intel in August 2016.
- Posted top benchmarks on both GPU and CPU architectures.
- Used assembly level optimizations to produce faster speeds.





# Keras

---

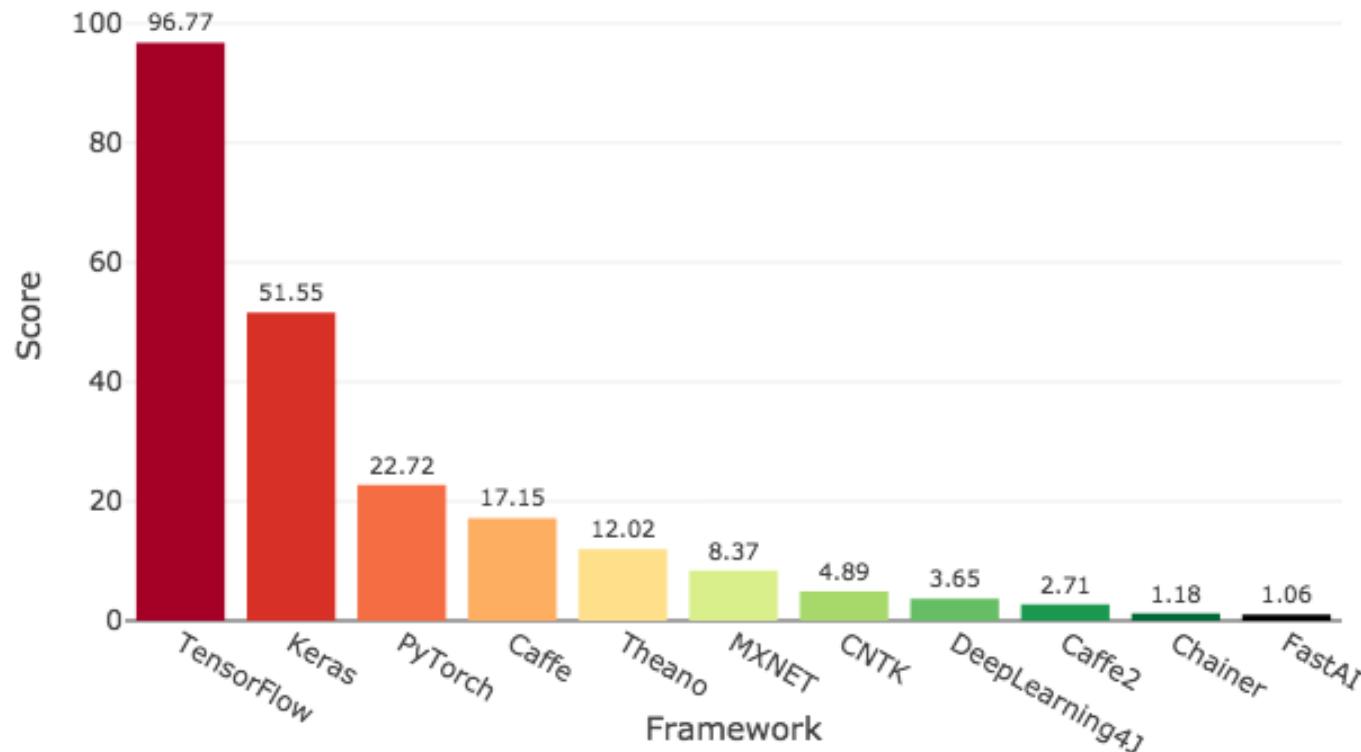
- Keras is high-level neural networks API, written in Python
- Built on top of either Theano, CNTK or TensorFlow
- Most powerful & easy to use for developing and evaluating deep learning models
- Allows for easy and fast Prototyping (through user friendliness, modularity, and extensibility)
- Support both convolutional networks and recurrent networks, as well as combinations of the two
- Runs seamlessly on CPU and GPU





# Power scores

Deep Learning Framework Power Scores 2018



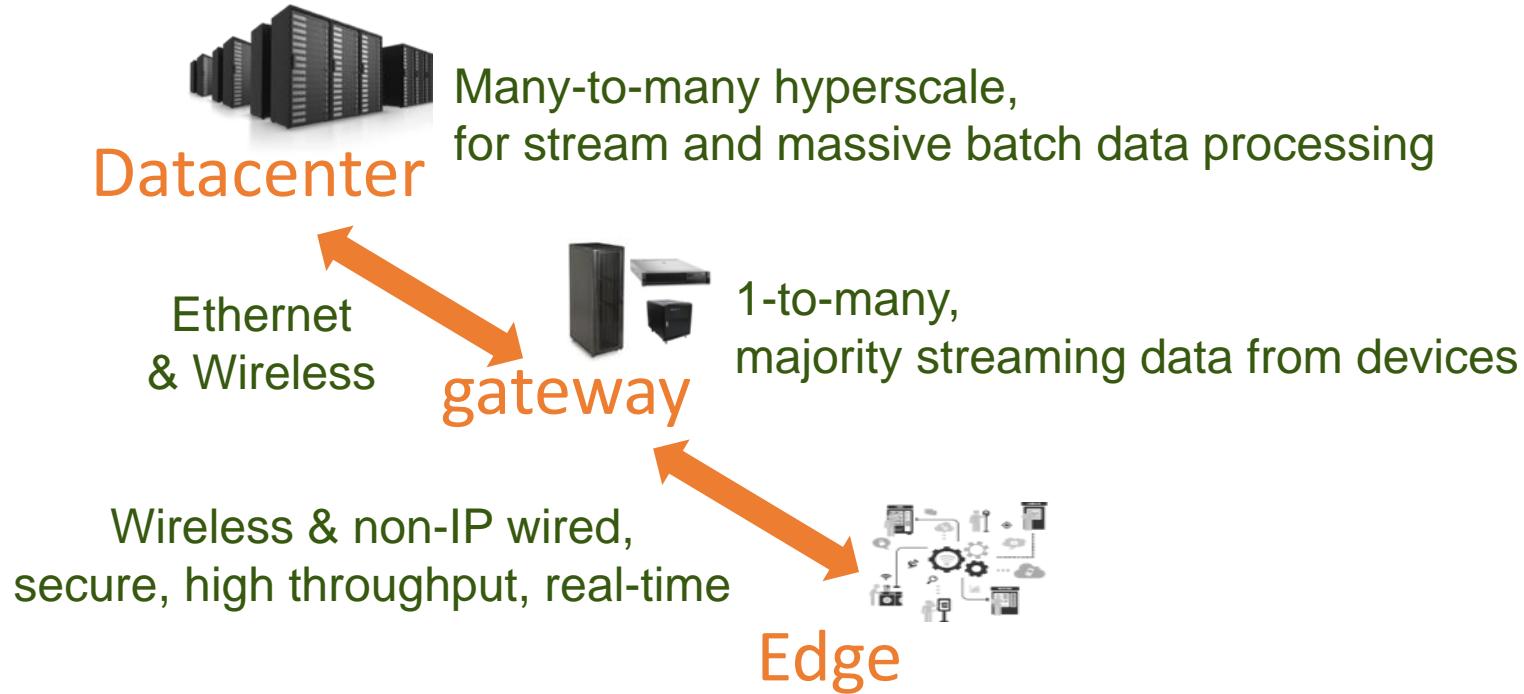


# Which framework

	Languages	Tutorials and training materials	CNN modeling capability	RNN modeling capability	Architecture: easy-to-use and modular front end	Speed	Multiple GPU support	Keras compatible
Theano	Python, C++	++	++	++	+	++	+	+
Tensor-Flow	Python	+++	+++	++	+++	++	++	+
Torch	Lua, Python (new)	+	+++	++	++	+++	++	
Caffe	C++	+	++		+	+	+	
MXNet	R, Python, Julia, Scala	++	++	+	++	++	+++	
Neon	Python	+	++	+	+	++	+	
CNTK	C++	+	+	+++	+	++	+	



# End to End Computing for AI





# End to End Computing for AI

---

There are various hardware requirements for different AI tasks.

- AI tasks can include **data collection** and fusion, training, and inference.
- The number of operations for **training** can be on the order of exaFLOPS, making this task more suited for datacenters.
- **Inference** takes fewer operations than training and can be done on both edge devices and at datacenters.
- Certain applications can have **constraints on the processor size and power**. For example, wearable devices and drones.



# End to End Computing for AI

## Datacenter

Datacenters are used to **store and process data for applications**, from websites to Internet of Things (IoT) systems.

- Low latency, high bandwidth – needed to access high compute resources.
- Reliability, lack of downtime, high performance.
- AI is the fastest-growing datacenter workload.
- A ~12X growth in demand by 2020 is expected.
- Training is typically done in a datacenter, allowing high processor power and physical size.



Datacenter

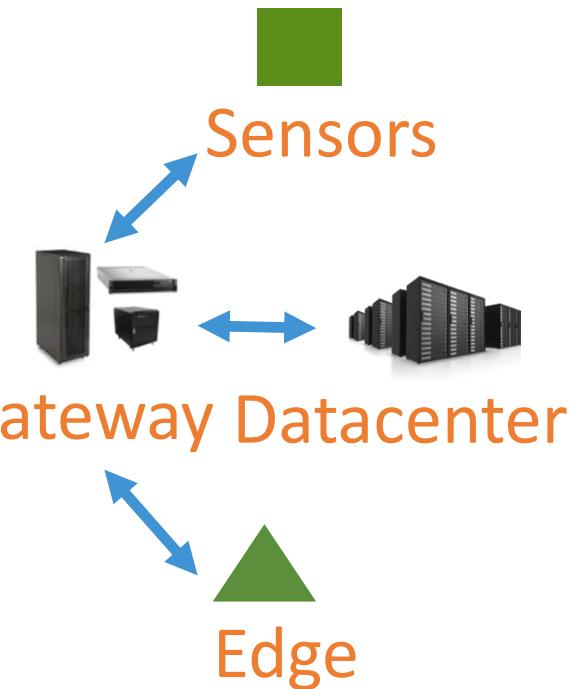


# End to End Computing for AI

## Gateway

Gateway computers route information from edge devices into and out of datacenters.

- **High bandwidth** – able to handle input from many devices and route correctly.
- Lightweight protocols – can't require extensive CPU usage, keeping gateway computer fast.
- Secure protocols – gateway computers are often a security point of failure.





# End to End Computing for AI

---

## Edge

Edge computing refers to computing happening as close as possible to where the computation is required.

- Sensors read information and compute a result directly on an Internet of Things (IoT) device, without sending information to data center.
- Reduces communication between sensors and datacenter.
- Uses resources that are not continuously connected to a network.
- Edge computing often used for inference rather than model training.





# End to End Computing for AI

## Example: Automated Driving

Autonomous vehicles produce ~4 terabytes of data per day.

One car, driving for one hour, requires ~5 exaFLOPS of computational power in order to safely keep it on the road.



DARPA Self-Driving  
Car Challenge Won in 2005



# End to End Computing for AI

## Automated Driving

Vehicle requires:

- Human-Machine Interface (HMI) – to build trust between driver and vehicle and provide advanced virtualization and graphics capabilities
- Scalable, powerful in-vehicle computing
- Sensor processing
- Environment modeling
- Driving functions



Car

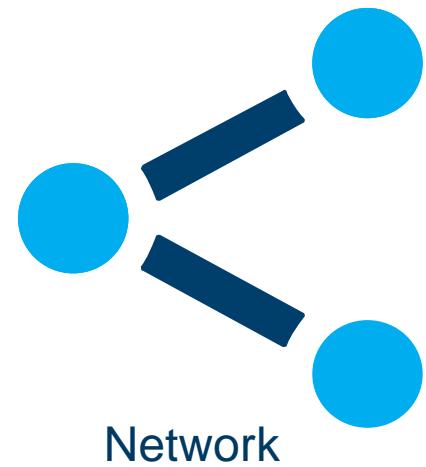


# End to End Computing for AI

## Automated Driving

Network requires:

- Vehicle-to-vehicle (V2V) and Vehicle-to-everything (V2X) communication
- Next-generation network connectivity
- Over-the-air-updates
- High-definition maps



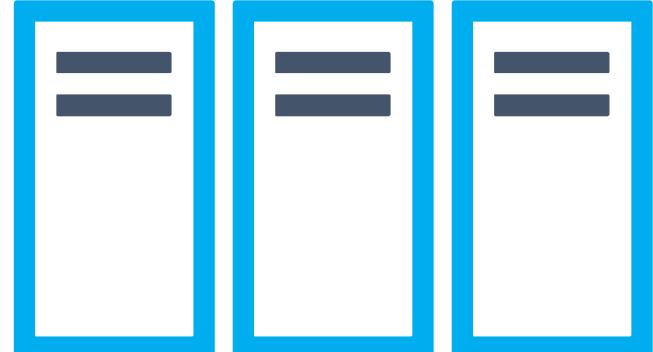


# End to End Computing for AI

## Automated Driving

Datacenter requires:

- High-performance data center and cloud
- AI to fleet management to data mining
- Model training
- Greater than real time inference





# AI Hardware: FPGA

---

## FPGA: Overview

Field Programmable Gate Arrays (FPGAs) are hardware that can be reconfigured – programmed in the field.

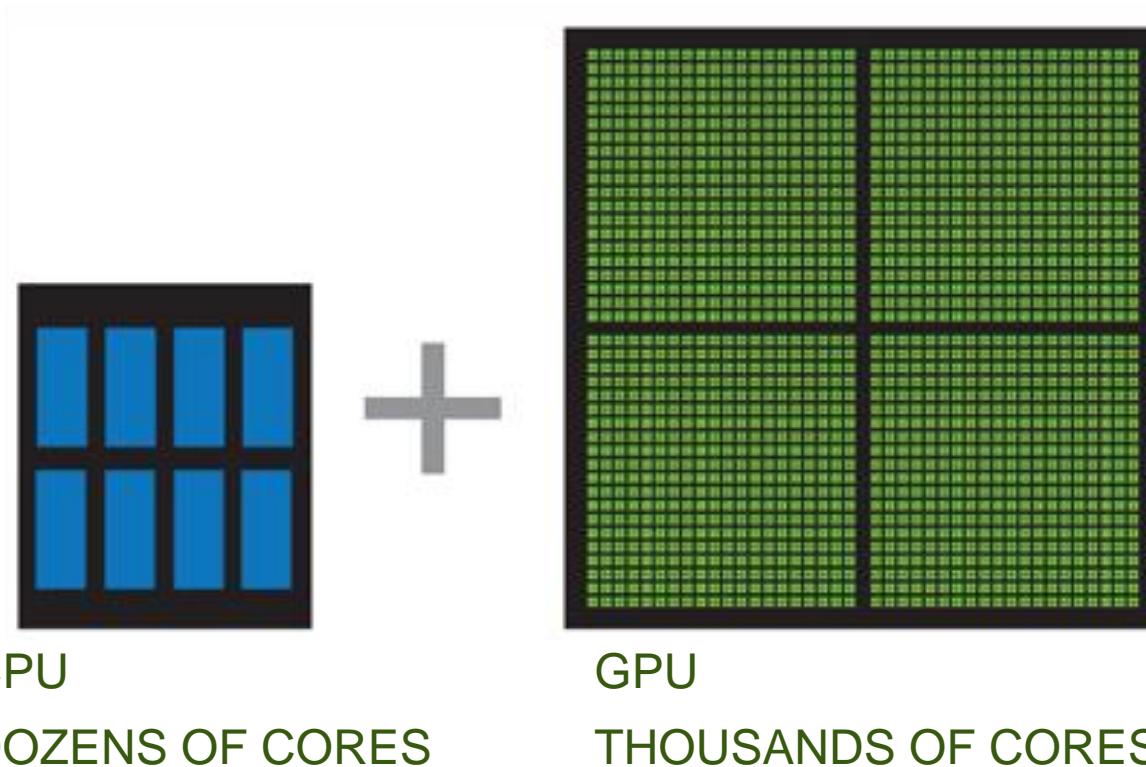
- FPGAs can become any digital circuit as long as the unit has enough logic blocks to implement that circuit.
- Enables the creation of custom hardware for individual solutions in an optimal way that other devices cannot efficiently support.
- High-throughput, low-latency processing of complex algorithms, such as neural networks.
- Flexible fabric enables direct connection of various inputs, such as cameras, without needing an intermediary.

<http://www.theneuromorphic.com/>





# AI Hardware: GPU





# AI Hardware: GPU

---

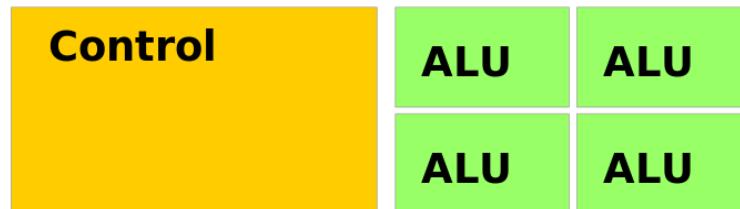
Originally designed to process graphics, GPUs have become a popular DL workhorse.

- Feature thousands of small, simple cores specialized for numeric, parallel computations.
- Many transistors dedicated to computation.
- GPUs excel at repeated similar instructions in parallel.
- Optimized for parallel data throughput computation.
- Major neural net breakthroughs since 2012 have been powered by GPU computations – performance has since increased >5x.
- Once the data is in the GPU memory the bottlenecks are small.
- NVIDIA is highly popular in discrete GPUs

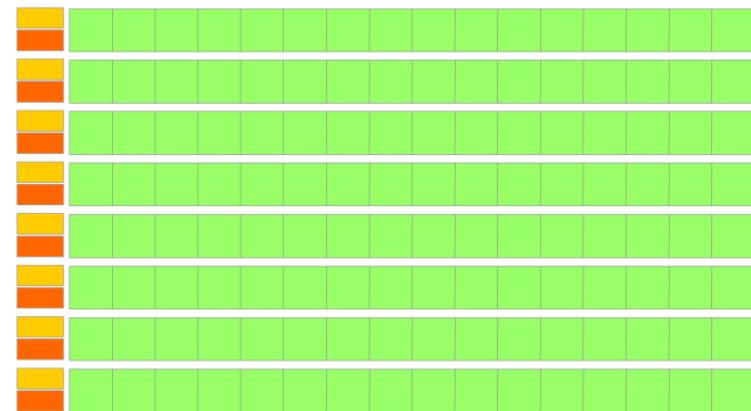


# AI Hardware: GPU

## CPUs vs GPUs



**CPU**



**GPU**



# AI Hardware: GPU

---

## CPUs vs GPUs

While GPUs are specialized processors, CPUs are still the main computation engines on most computers.

- CPUs have dozens of cores compared to GPUs that have thousands of less powerful cores.
- CPUs have fewer arithmetic logic units (ALUs) and a lower compute density than GPUs
- CPUs are lower latency and have larger cache memory compared to GPUs



# AI Hardware: GPU

---

## CPUs vs GPUs

While GPUs are specialized processors, CPUs are still the main computation engines on most computers.

- GPUs are designed for **parallel tasks** and perform well when a single instruction is to be performed over a large amount of data.
- GPUs have additional overhead when copying data from main memory is required so CPUs can be better when a large number of memory swaps are needed.
- GPUs are not good for tasks that cannot be parallelized or when heavy processing on fewer data streams is needed. CPUs excel at serial tasks.
- CPUs are easy to program – popular programming languages compile to machine code, to be run on CPU by default.



# AI Hardware: GPU

---

## NVIDIA GPUs

NVIDIA's main business is in dedicated hardware for discrete graphics processors.

Several factors have made NVIDIA highly popular in this space.

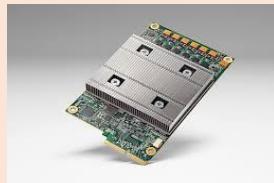
- CUDA\* framework which lets developers write code in C++, Python\*, and other popular languages that run optimized operations on the GPU.
- Early incorporation of GPUs with cloud services, such as Amazon Web Services\*.
- For several years, NVIDIA facilitated ecosystem adoption by optimizing their libraries and abstracting the complexities of the GPU through SDKs, tools, and libraries.



# AI Custom Hardware

AI runs on both general purpose processors and on specialized hardware.

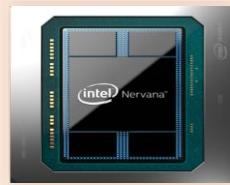
## Specialized Hardware



Google  
TPU\*



Apple Neural  
Engine\*



Intel®  
Nervana™  
NNP



Intel®  
Movidius™



# AI Custom Hardware

---

## Google Tensor Processing Unit\* (TPU)

Google's TPU\* is the first major example of a chip designed for AI.

- Google's first-gen TPU (2015) was designed specifically for fast inference.
- Unlike a GPU, no capabilities for graphics tasks, such as rasterization or texture mapping.
- Second-gen (2017) increased the precision available for computations, making this version usable for training as well.



# AI Custom Hardware

---

## Apple Neural Engine\*

Apple Neural Engine\* system is on a chip designed for fast inference.

- Apple Neural Engine shipped on late 2017 iPhones.
- Separate from main CPU and GPU on iPhone.
- Specifically designed for fast neural net inference, capable of 600 billion operations per second.
- Highlighted importance of fast neural net inference to Apple's ability to provide its desired user experience.



# AI Custom Hardware

---

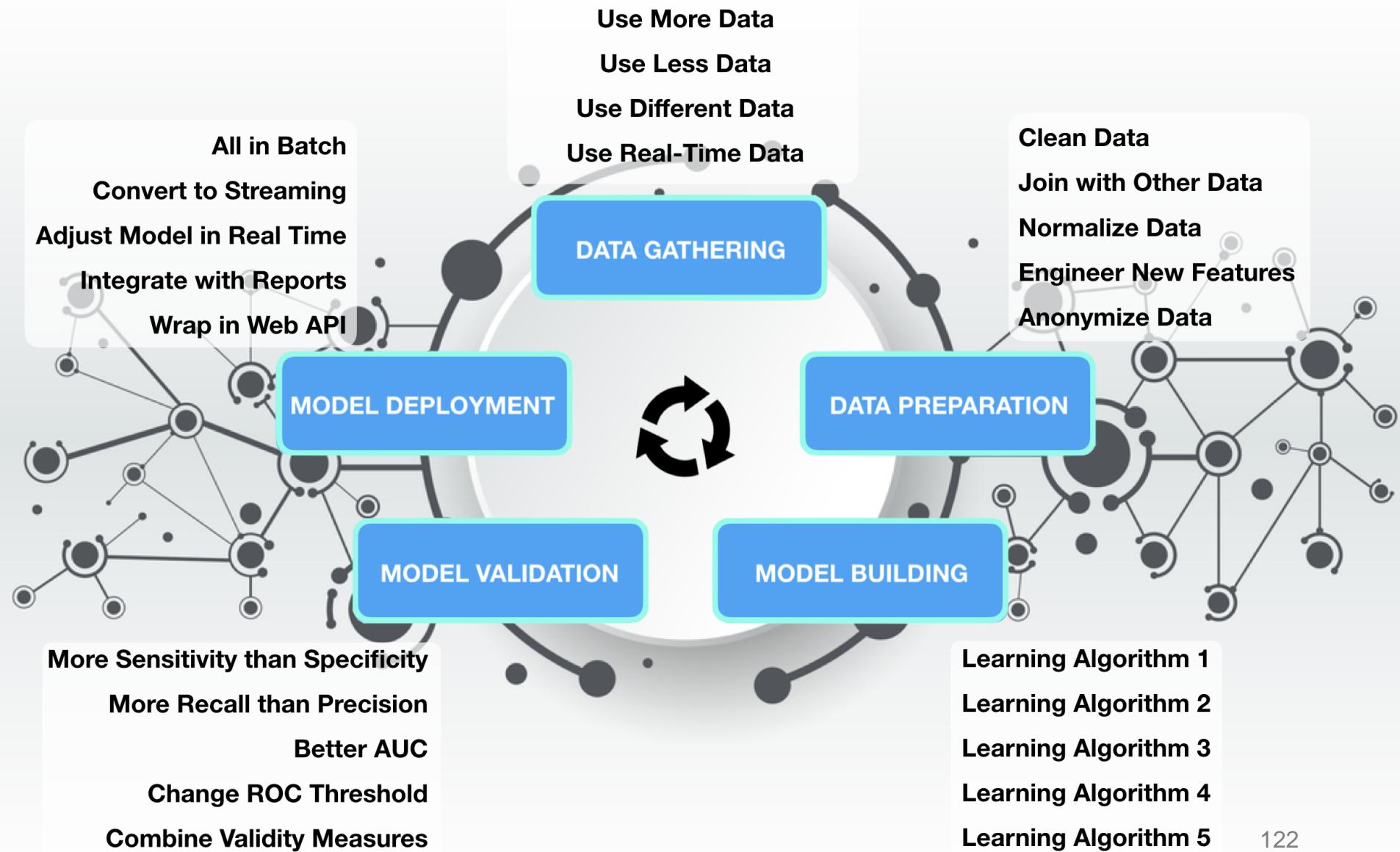
## Apple Neural Engine\*

Apple Neural Engine\* system is on a chip designed for fast inference.

- Apple Neural Engine shipped on late 2017 iPhones.
- Separate from main CPU and GPU on iPhone.
- Specifically designed for fast neural net inference, capable of 600 billion operations per second.
- Highlighted importance of fast neural net inference to Apple's ability to provide its desired user experience.

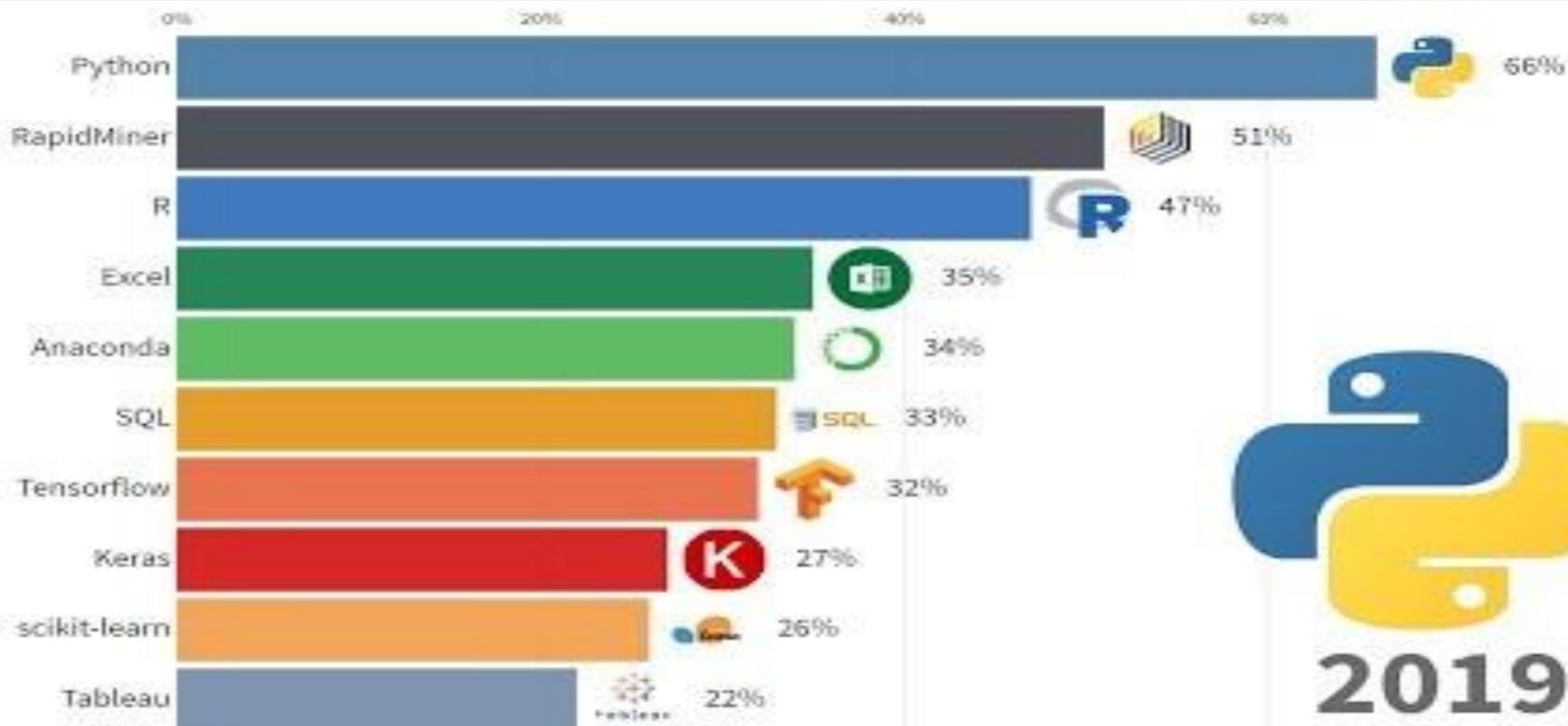


# AI/ML Workflow



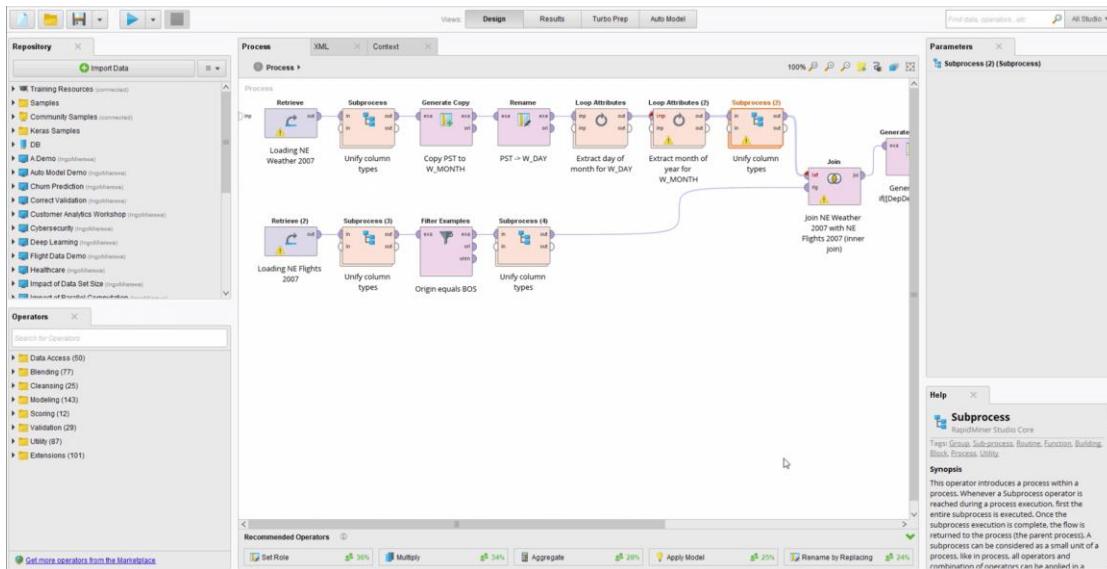


# What are the popular tools?

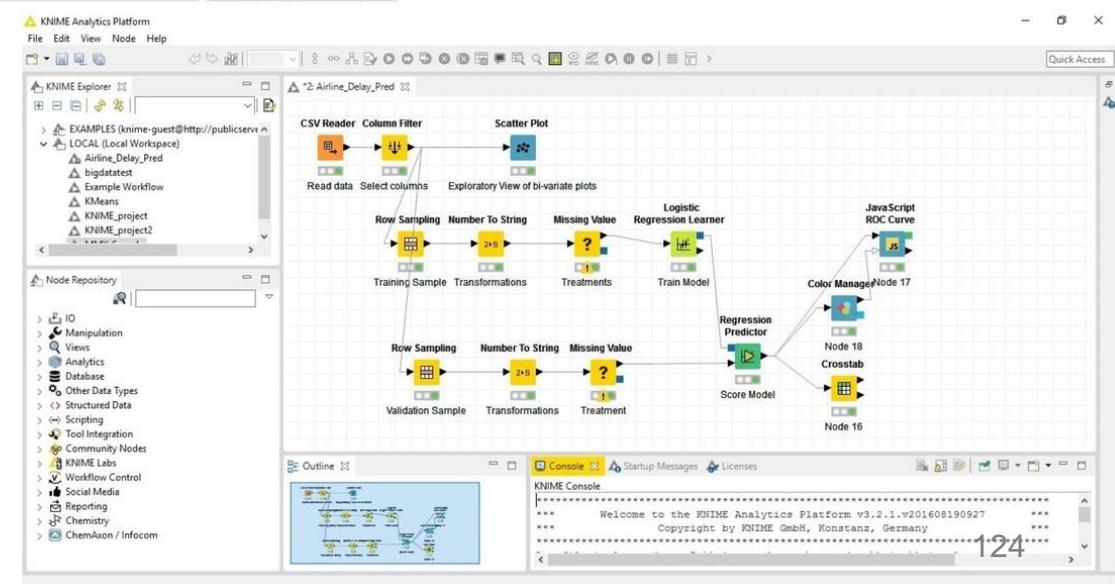




# Graphical Tools (ML/DS)



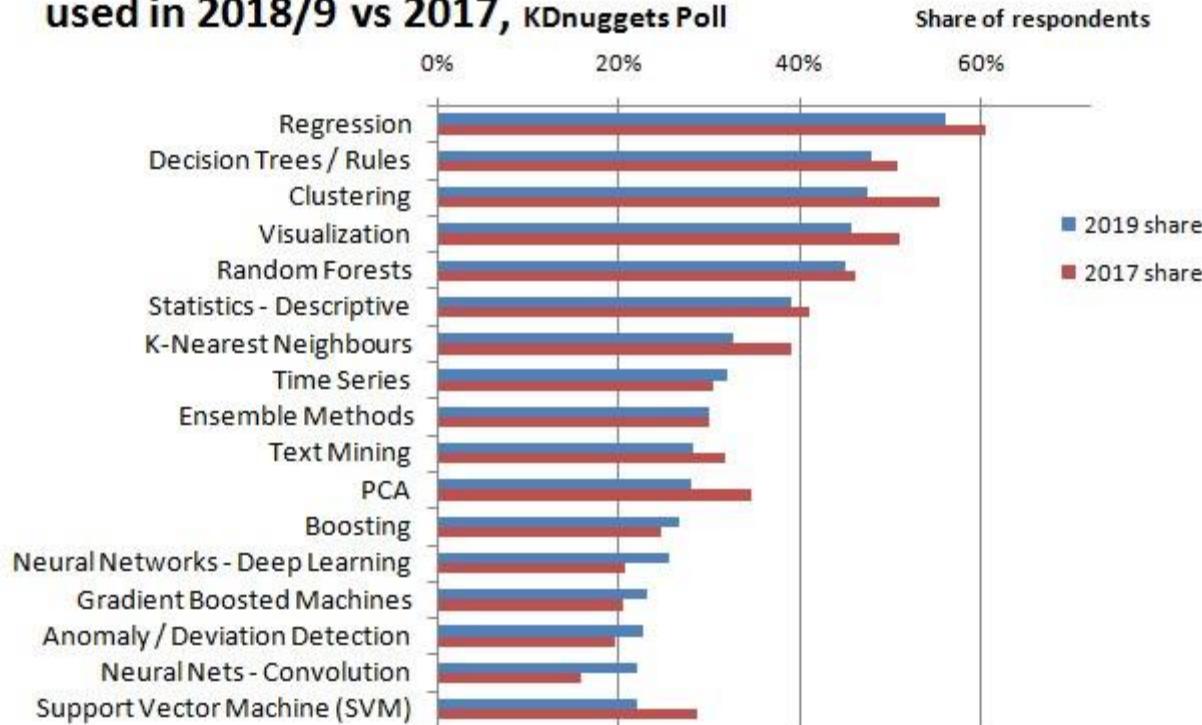
RapidMiner





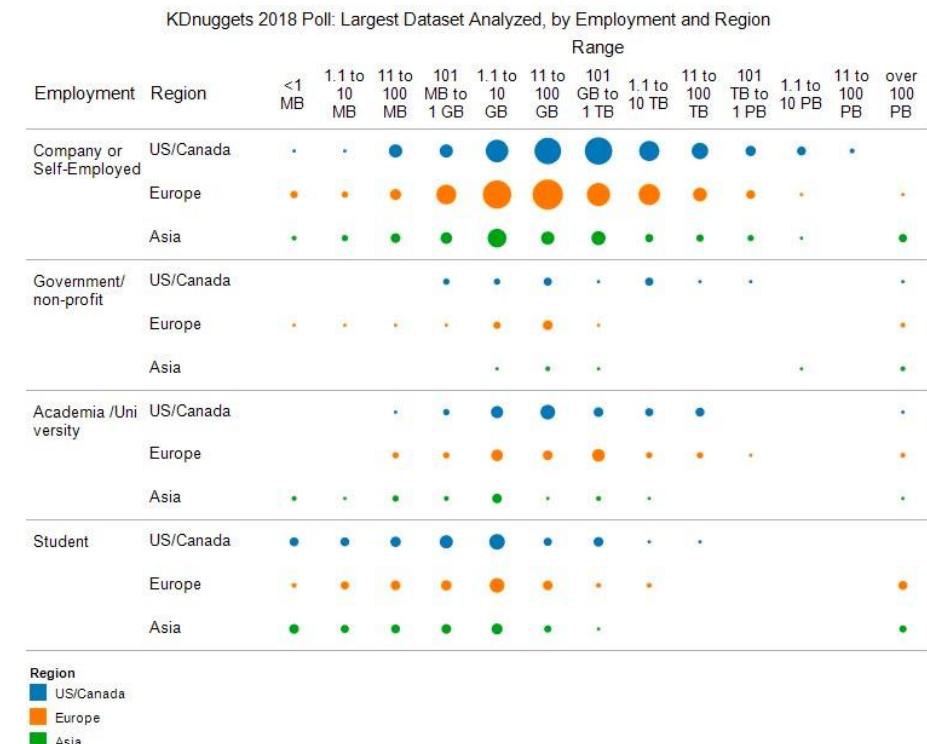
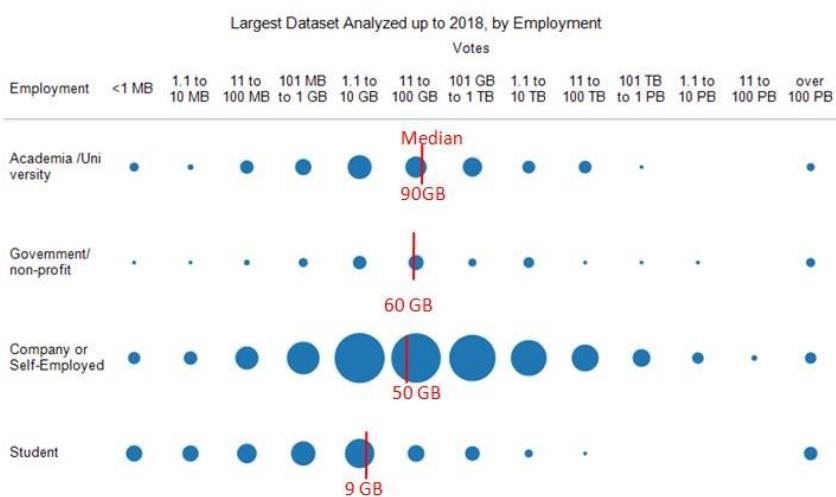
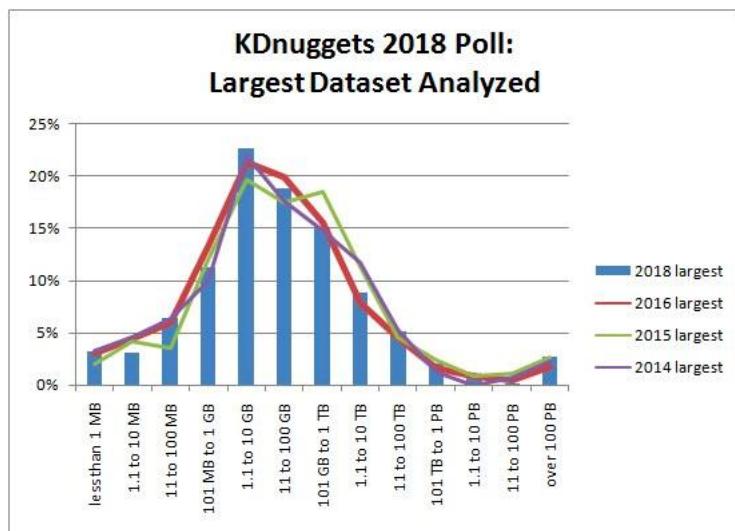
# Top Methods/algorithms

**Top Data Science, Machine Learning  
Methods, Algorithms  
used in 2018/9 vs 2017, KDnuggets Poll**





# Datasets size



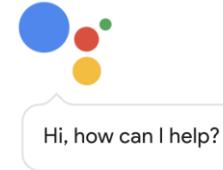
# AI Services

---

# AI Services




- Google Search
- Google Assistant ([hands on](#))
- Google Photo (image recognition)
- Speech Recognition
  
- Google's AI Services for Companies
  - <https://experiments.withgoogle.com/collection/ai>
  
- Google's cloud-based AI Tools
  - <https://ai.google>
  
- Google's AI Experiments:
  - <https://experiments.withgoogle.com/ai>
  
- Do-it-Yourself AI:
  - <https://aiyprojects.withgoogle.com/voice/>

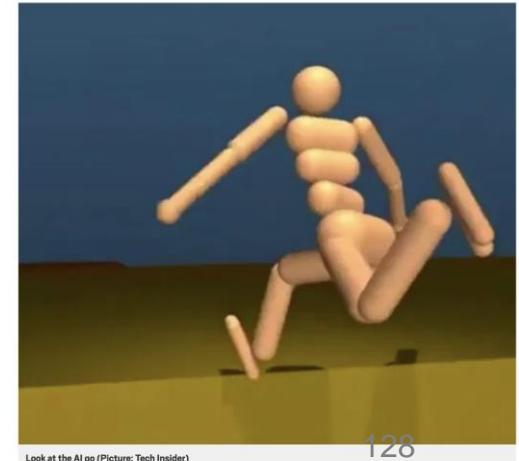


Meet your Google Assistant.

Ask it questions. Tell it to do things. It's your own personal Google, always ready to help.

**Beware – Google's AI is so smart it just taught itself to walk without any human help**

 Jimmy Nsubuga Monday 17 Jul 2017 6:31 pm



## Voice Kit

Do-it-yourself intelligent speaker. Experiment with voice recognition and the Google Assistant.



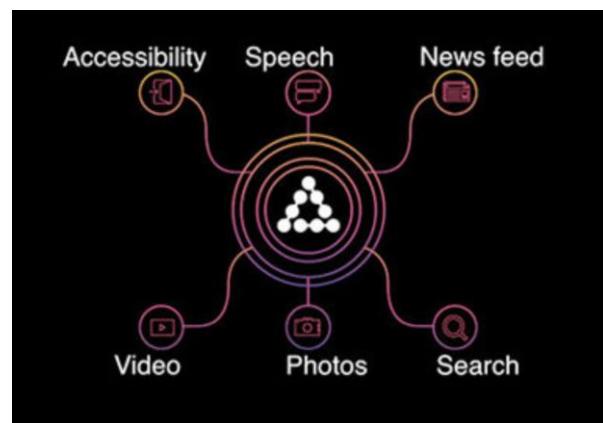
## Vision Kit

Do-it-yourself intelligent camera. Experiment with image recognition using neural networks.



# AI Services

- Facebook Photo search
- FB Learner Flow (<https://code.fb.com/ml-applications/introducing-fblearner-flow-facebook-s-ai-backbone/>)
- Text Analytics (Deep Text)
- Pattern Recognition to Prevent Suicides
- Improving 360 Degree Photos
- Computer Vision
- Facebook Personal Assistant M (experiment)
- Facebook Messenger Platform Chatbot
- Facebook's AI research Activities
  - <https://research.fb.com/category/facebook-ai-research/>



TECHNOLOGY NEWS NOVEMBER 28, 2017 / 12:05 AM / A YEAR AGO

**Facebook will use AI to help correct skewed 360-degree photos**

The company has a technique for dealing with big file sizes, too.

**Facebook to expand artificial intelligence to help prevent suicide**

David Ingram

3 MIN READ



129



# AI Services

- Amazon Recommended Products
- Alexa Personal Assistant
- Cloud Storage
- Amazon's AI platform:
  - Amazon Lex
  - Amazon Polly
  - Amazon Recognition

**LEARNING TOOLS**

Get deep with machine learning

**AWS DeepRacer**

AWS DeepRacer is a fully autonomous 1/18th-scale race car designed to help you learn about reinforcement learning through autonomous driving.

- Experience the thrill of the race in the real world when you deploy your RL model onto AWS DeepRacer.
- Load your own SnekTutor and then train, test, and iterate on the track using the AWS DeepRacer 3D racing simulator.
- Starting in 2019, compete in the world's first global autonomous racing league, to race for prizes and a chance to advance to win the coveted AWS DeepRacer Cup.

[Learn more »](#)

---

**AWS DeepLens**

AWS DeepLens is the world's first deep learning-enabled video camera for developers. Integrated with Amazon SageMaker and many other AWS services, it allows you to get started with deep learning in less than 10 minutes through sample projects with practical, hands-on examples.

- Choose your deep learning model from the AWS DeepLens pre-trained model library, or your own models trained with Amazon SageMaker.
- Deploy your model to the device with a single click.
- Watch the results in real time in the AWS Management Console.

[Learn more »](#)





**Recommendations**

Personalize experiences for your customers with the same recommendation technology used at Amazon.com.

[AMAZON PERSONALIZE »](#)



**Forecasting**

Build accurate forecasting models based on the same machine learning forecasting technology used by Amazon.com.

[AMAZON FORECAST »](#)



**Image and Video Analysis**

Add image and video analysis to your applications to catalog assets, automate media workflows, and extract meaning.

[AMAZON REKOGNITION »](#)



**Advanced Text Analytics**

Use natural language processing to extract insights and relationships from unstructured text.

[AMAZON COMPREHEND »](#)



**Document Analysis**

Automatically extract text and data from millions of documents in just hours, reducing manual efforts.

[AMAZON Textract »](#)



**Voice**

Turn text into lifelike speech to give voice to your applications.

[AMAZON POLLY »](#)



**Conversational Agents**

Easily build conversational agents to improve customer service and increase contact center efficiency.

[AMAZON LEX »](#)



**Translation**

Expand your reach through efficient and cost-effective translation to reach audiences in multiple languages.

[AMAZON TRANSLATE »](#)



**Transcription**

Easily add high-quality speech-to-text capabilities to your applications and workflows.

[AMAZON TRANSCRIBE »](#)



# Amazon Rekognition

---

Amazon Rekognition Video をご紹介します。



# AI Services

- Cortana - <https://www.microsoft.com/en-us/windows/cortana>
- Presentation Translator - <https://translator.microsoft.com/help/presentation-translator>
- HoloLens
- InnerEye - <https://www.microsoft.com/en-us/research/project/medical-image-analysis/>
- Azure Microsoft Cloud Service –
- AI for Earth - <https://www.microsoft.com/en-us/ai/ai-for-earth>
- AI Language Translator - <https://www.microsoft.com/en-us/translator/>  
<https://www.bing.com/translator> (demo)



Microsoft | AI Products & Services Approach More All Microsoft Sign in

**AI for Earth**

AI for Earth puts Microsoft cloud and AI tools in the hands of those working to solve global environmental challenges.

▷ Play AI for Earth video

## Areas of focus

AI for Earth awards grants to projects that use artificial intelligence to address four critical areas that are vital for building a sustainable future.

[Learn about AI for Earth grants >](#)



# AI Services

- Cognos Analytice - <https://www.ibm.com/sg-en/products/cognos-analytics>
- Tone Analyzer - <https://tone-analyzer-demo.ng.bluemix.net> (demo)
- Discovery - <https://discovery-news-demo.ng.bluemix.net>
- Visual Recognition -  
<https://www.ibm.com/watson/services/visual-recognition/demo/#demo>
- Text to Speech - <https://text-to-speech-demo.ng.bluemix.net/> (audio streaming does not work on mobile browser)

The screenshot shows the 'Tone Analyzer' service page. It includes a description of the service, a note about data handling, and a 'Start for free in IBM Cloud' button.

The screenshot shows a list of sample use cases: Tweets, Online Review, Email message, Product Review in French, and Your own text. It also includes a note about analyzing customer engagement data and a link to the Tone Analyzer Customer Engagement Endpoint.

The screenshot shows a custom classifier trained on insurance images. It displays a main image of a vehicle with graffiti and a list of detected categories with their confidence scores:

Category	Score
vandalism	0.64
flat_tire	0.53
broken_windshield	0.11
motorcycle_accident	0.06

Below the main image, there are smaller images of car parts, and a note says: "Select an image on the left to evaluate how this Custom Model analyzes different images".



# AI Services

- Speech Recognition on Siri
- QuickType
- A11 Bionic Chip – Core ML
- Apple Music
- Apple HomePod
- Apple Photos



**Apple acquires AI tech that seeks to understand your photos**

Regaind can tell good pics from bad ones, and interpret what's going on.

**Apple has new self-driving car hardware covered with iPod-style white plastic**

Kif Leswing, Business Insider US

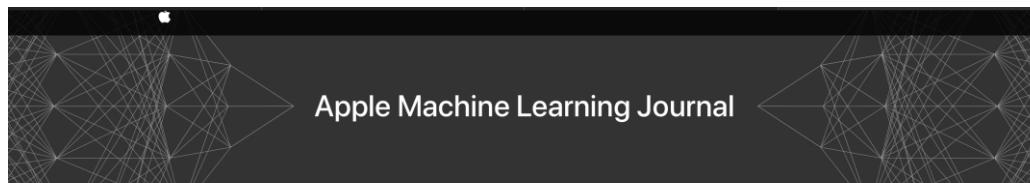
October 18, 2017

71,188 views | Dec 26, 2016, 07:05am

**Apple Publishes Its First Artificial Intelligence Paper**



Aaron Tilley Forbes Staff



Optimizing Siri on HomePod in Far-Field Settings

Vol. 1, Issue 12 • December 2018  
by Audio Software Engineering and Siri Speech Team



# AI Services

Robots Run the Warehouses ([link](#))

Innovation

## Alibaba lets AI, robots and drones do the heavy lifting on Singles' Day

This year's November 11 shopping ritual will engage a recommendation algorithm, robots, and chatbots capable of understanding human emotion

Topic | Singles' Day (11.11)

### SMART CUSTOMER SERVICE

Ali Assistant is a chatbot that handles both spoken and written queries, acting as customer-service rep and personal shopping assistant. It is capable of handling up to

**95%**

of customer service enquiries



Intelligent Machines

## Alibaba's AI Fashion Consultant Helps Achieve Record-Setting Sales

AI will blur the line between online and offline retail.

### BIG DATA

With nearly

**500 million**

active users across its websites and apps, Alibaba has a vast repository of consumer data that can be processed and analyzed by AI programs continuously in real time, leading to increasingly accurate predictions and a better shopping experience.



### COMPUTING POWER

Alibaba has built up one of the world's largest networks of interconnected computer servers to run its e-commerce empire, backed by an operating system that can process more than

**175,000**  
transactions per second.



# Magic Quadrant for Cloud Infrastructure and Platform Services



10/3/2020

Gartner Reprint

Gartner

Licensed for Distribution

## Magic Quadrant for Cloud Infrastructure and Platform Services

Published 1 September 2020 - ID G00441742 - 39 min read

By Analysts Raj Bala, Bob Gill, Dennis Smith, David Wright, Kevin Ji

The capability gap between hyperscale cloud providers has begun to narrow; however, fierce competition for enterprise workloads extends to secondary markets worldwide. Infrastructure and operations leaders should evaluate cloud providers with a broad range of use cases and a wide market presence.

### Market Definition/Description

Cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using internet technologies. Cloud infrastructure and platform services (CIPS) are defined as standardized, highly automated offerings, in which infrastructure resources (e.g., compute, networking and storage) are complemented by integrated platform services. These include managed application, database and functions as-a-service offerings. The resources are scalable and elastic in near-real time and are metered by use. Self-service interfaces are exposed directly to the customer, including a web-based user interface (UI) and an API. The resources may be single-tenant or multitenant, and can be hosted by a service provider or on-premises in the customer's data center.

The scope of this Magic Quadrant has changed, compared with its predecessor, the "Magic Quadrant for Cloud Infrastructure as a Service." Gartner has developed this Magic Quadrant to reflect the changing dynamics of cloud services offered and the ways that enterprise customers adopt them. Ultimately, hyperscale cloud providers, and the broad array of services they offer beyond infrastructure as a service (IaaS), have found strategic importance in Gartner's enterprise clients and the Magic Quadrant needed to evolve to reflect as much.

The scope of the Magic Quadrant for CIPS includes IaaS and integrated platform as a service (PaaS) platforms. These include application PaaS (aPaaS), functions as a service (FaaS), database PaaS (dbPaaS), application developer PaaS (adPaaS) and industrialized private cloud offerings that are often deployed in enterprise data centers.

### Understanding the Vendor Profiles, Strengths and Cautions

CIPS providers that target enterprise and midmarket customers generally offer high-quality service, with excellent availability, good performance, high security and good customer support. Exceptions will be noted in this Magic Quadrant's evaluations of individual providers. When we say "all providers," we specifically mean "all the evaluated providers included in this Magic

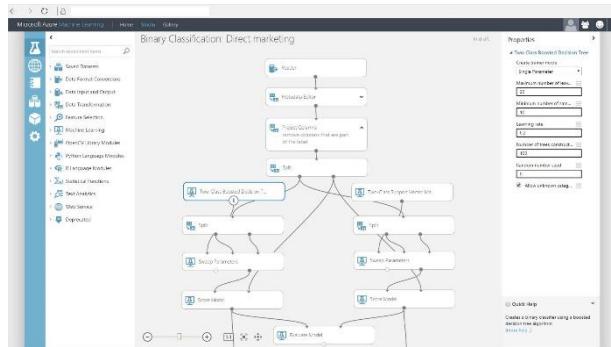
<https://www.gartner.com/doc/reprints?id=1-1ZDZDMTF&ct=200703&sl=eb>

1/23

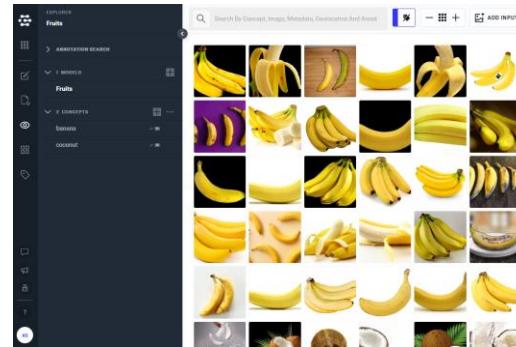


# Other AI services

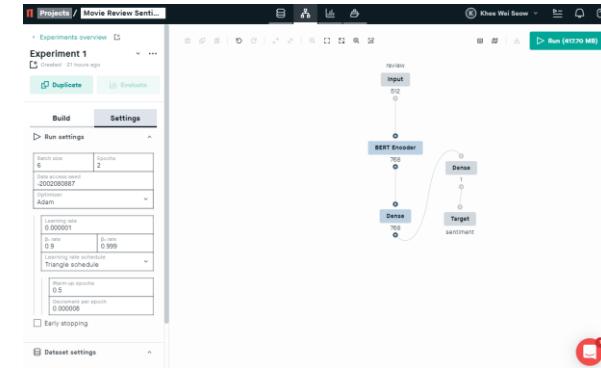
Microsoft Azure  
Machine Learning Studio  
(Classic)



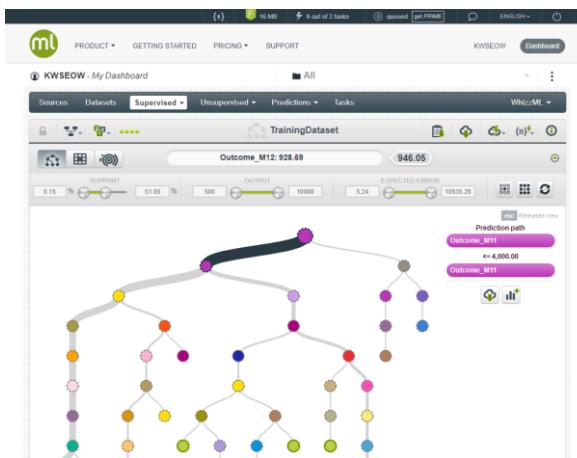
Clarifai



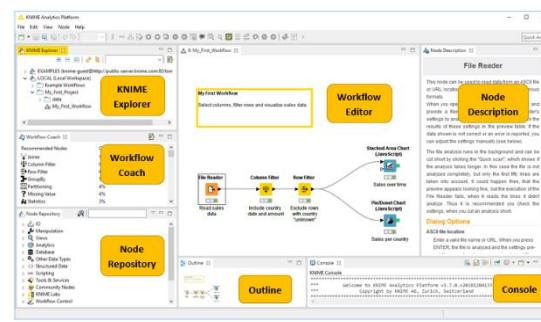
Peltarion



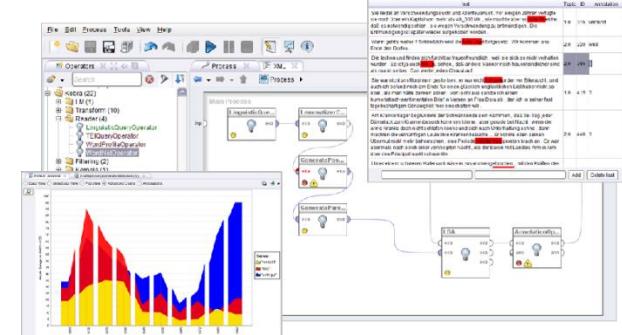
bigml



KNIME



Rapidminer





# Function specific AI services

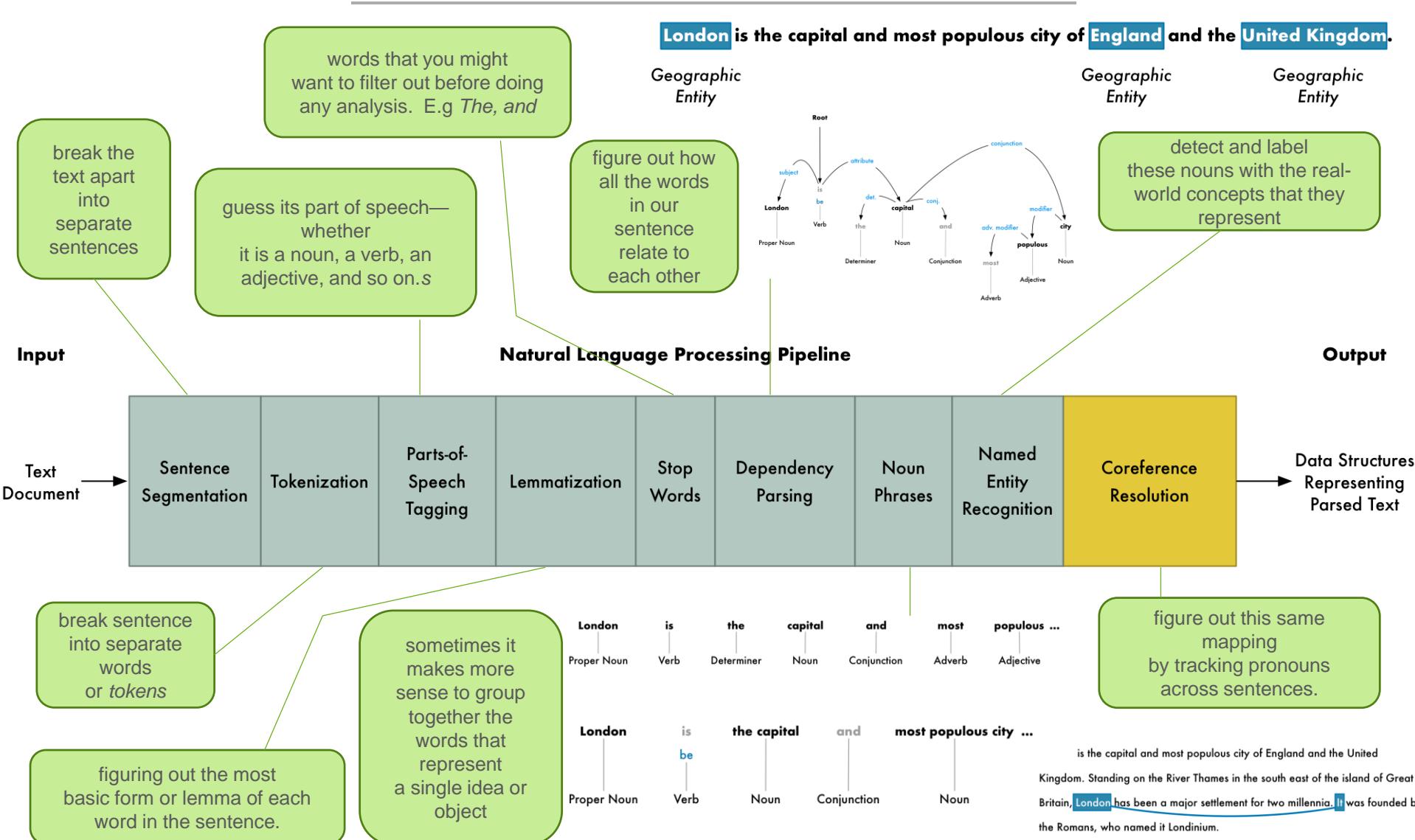
Sales	Outreach.io
Virtual Human	<a href="https://www.quantumcapture.com/ctrl-human">https://www.quantumcapture.com/ctrl-human</a>
HR Services	<a href="https://leena.ai/HR-FAQ">https://leena.ai/HR-FAQ</a>
Scheduling	<a href="https://x.ai/how-it-works/">https://x.ai/how-it-works/</a>
Enterprise support functions	<a href="https://www.soapbox.ai/">https://www.soapbox.ai/</a>
Sales Bots	<a href="https://octaneai.com/">https://octaneai.com/</a>
AI-Powered Transcription	<a href="http://capiro.ai/index.html">http://capiro.ai/index.html</a>
Hiring	<a href="https://hiringsolved.com/product">https://hiringsolved.com/product</a>
Programming	<a href="https://www.codata.com/enterprise">https://www.codata.com/enterprise</a> <a href="https://kite.com/">https://kite.com/</a>

# Hands On

---



# Hands-on NLP





# Hands-on NLP

- Use Google Cloud Platform, we will:
  - Classify Text
  - Named Entity Recognition
  - Sentiment Analysis
  - Syntax Analysis
- Activity 1 & 2

Google Cloud      Why Google    Solutions    Products    Pricing    Getting Started    [Contact Sales](#)

Google is named a Leader in 2020 Magic Quadrant for Cloud Infrastructure and Platform Services. [Get the report.](#)

Solve more with Google Cloud

Meet your business challenges head on with cloud computing services from Google.

[Go to console](#)

Learn how businesses are using innovation to accelerate transformation.

Modernize your workloads on world-class infrastructure	Protect your data with multilayered security	Drive decision-making with intelligent analytics	Adopt hybrid and multi-cloud without vendor lock-in
Migrate quickly with pre-packaged <a href="#">cloud infrastructure solutions</a> for SAP, VMware, Windows, Oracle, data center migration, and other enterprise workloads.	<a href="#">Secure-by-design infrastructure</a> protects your data, applications, and users, with advanced anti-malware and threat detection.	Uncover actionable insights from your data, with a suite of scalable solutions for <a href="#">data warehouses</a> , analytics, and AI and machine learning.	Build applications once and run them in <a href="#">hybrid and multi-cloud</a> environments with other cloud providers.

**Step 1:**  
Watch and listen to the instructor's demonstration



20 mins

**Step 2:**  
- Do on your own

**Individual Activity**

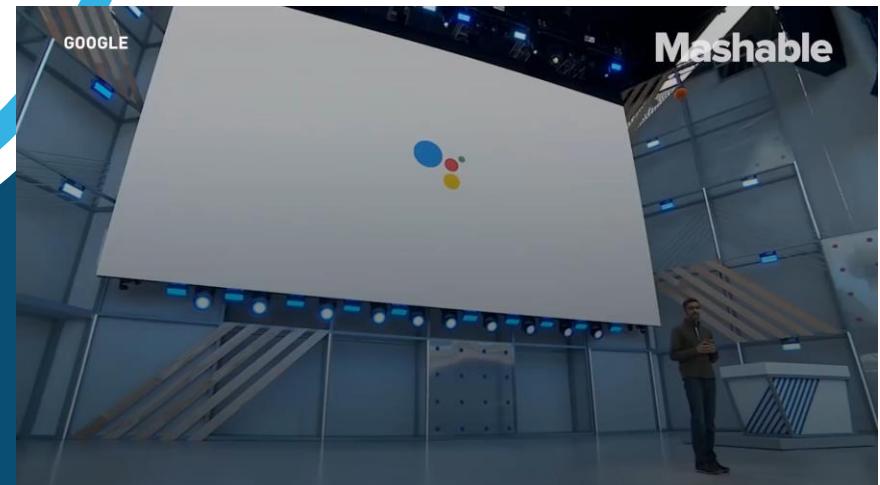


40 mins



# 15 Mins Break

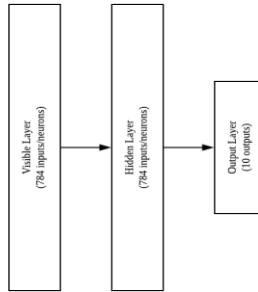
[bit.ly/google\\_duplex2019](https://bit.ly/google_duplex2019)



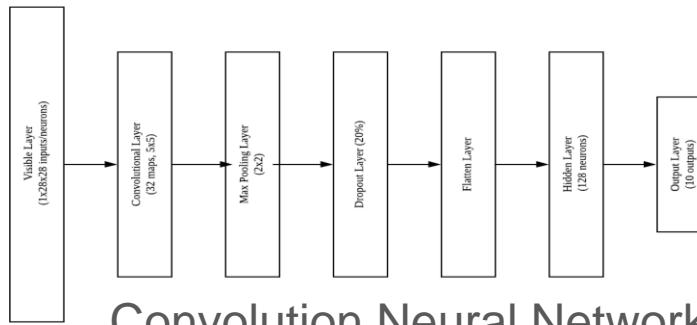
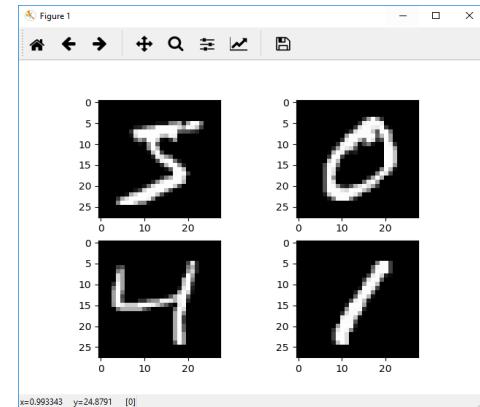


# Hands on – Object Recognition

- Recognition handwritten digits (MNIST dataset)
- Using a Multilayer Perceptrons Neural Network
- Using a simple Convolution Neural Network



Multilayer Perceptrons  
Neural Network



Convolution Neural Network

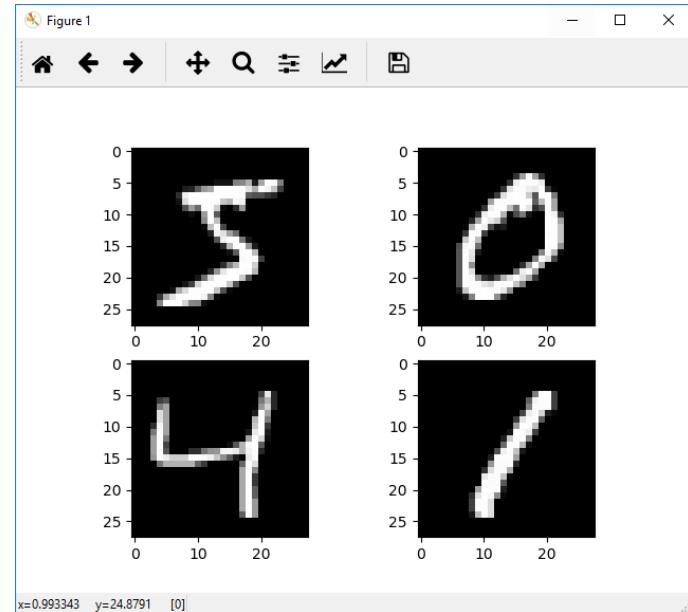




# Hands on – Object Recognition

- Workflow

1. Load Data.
2. Define Model.
3. Compile Model.
4. Fit/Train Model.
5. Evaluate Model.
6. Predict with new data.



**Step 1:**  
Watch and listen to the  
instructor's demonstration



20 mins

**Step 2:**  
- Do on your own

**Individual Activity**

K Keras



40 mins

# Many Examples of how AI is applied

---



# Applications

## Navigation



Google & Waze find the fastest route, by processing traffic data.

## Ride sharing



Uber & Lyft predict real-time demand using AI techniques, machine learning, deep learning.

## Audience



Facebook & Twitter use AI to decide what content to present in their feeds to different audiences.

## Content



Image recognition and sentiment analysis to ensure that content of the appropriate "mood" is being served.

## Natural language



We carry around powerful natural language processing algorithms in our phones/computers.

## Object detection

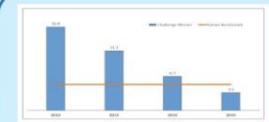


Cameras like Amazon DeepLens\* or Google Clips\* use object detection to determine when to take a photo.

## Ride sharing



Deep Learning "proven" to work for image classification.



Models outperform humans on image classification.



Object detection models beat previous benchmarks.

2012

2015

2016

## Application Area: Abandoned Baggage Detection

- We can automatically detect when baggage has been left unattended, potentially saving lives.
- This system relies on the breakthroughs we discussed:
  - Cutting edge object detection.
  - Fast hardware on which to train the model (Intel® Xeon® processors in this case).



Abandoned baggage



# Finance

- Better Customer Service
- More Reliable Investment Services with Robot Advisor
- Greater Efficiency with Less Paperwork
- Improved Financial Security

JPMorgan Chase Uses COIN Machine Learning Program To Eliminate 360K Lawyer Hours A Year



## TREND 1



### **Readying for banking's shift from mobile-first to AI-first**

Artificial intelligence (AI) in banking is not new. Banks are already using AI in heavily-manual processes for accuracy, efficiency, speed and cost benefits. What is new, however, is the move of AI beyond process to interaction. The next stage of AI in banking will be toward simple and smarter interfaces: drawing on machine learning that adapts to data and interactions to improve areas like fraud detection, and tapping AI-enabled tools (like centralized platforms/assistants or messaging bots) to better converse with and offer services to customers in the front-office. Relying on AI for some internal and external interactions will help elevate the customer experience and move staff to more judgment-based and higher value added roles.



# AI in Fraud Detection

---





# Fraud Detection

**Traditionally:** Fraud is on the rise, but fraud detection is a challenging problem to solve correctly.

- Historically, a predefined rule-set was used for fraud identification, but this approach misses much of the nuance that surrounds fraud
- 1/3 of falsely identified fraud events result in lost customers
- In the US, this loss is worth 13 times the cost of actual fraud



**Now with AI:** With ML techniques, banks can predict fraud based on a behavioral baseline to compare against.

- Uses historical shopping data and shopping habits of customers
- Compares new data to baseline to determine likelihood of fraud



## Example: Sift Science

- Established a fraud data consortium developed from over 6000 websites to leverage large-scale real-time ML
- Autonomously learns new fraud patterns based on billions of user actions





# Risk Management

**Traditionally:** New regulations force tighter control on financial institutions.

- New business model disruptions
- Increasing pressure on costs and returns



**Now with AI:** ML can help discern the credit worthiness of potential customers

- Tailor a financial portfolio to fit the goals of the user using ML algorithms.
- Financial institutions can develop early warning systems for automated reporting, portfolio management, and recommendations based on ML.



## Example: ZestFinance

- Traditional underwriting systems make decisions using few data points.
- Those with a limited credit history are often denied credit, ultimately leading to loss of revenue for lenders.
- ZestFinance leverages thousands of data sources together with ML to more accurately score borrowers, even people with a small credit history.





# Stock Trading

**Traditionally:** The speed and volume of information is daunting.

- The market is reactionary.
  - It's difficult to remain competitive while relying on traditional trading methods.
  - Fundamental analysis is unable to show the entire financial picture.



**Now with AI:** Companies use massive datasets together with DL methods for better forecasting.

- Data pulled from financial, political, and social media
  - Analyst reports combined.



## **Example:** Sentient Technologies, and Learning Evolutionary Algorithm Framework (LEAF\*)

- Manages millions of data points to find trends and make successful stock trades.
  - AI algorithms identify and combine successful trading patterns.
  - Successful strategies are tested in the real world, evolving autonomously with LEAF.
  - Sentient has received more funding than any other AI company.





# AI in Travel

---





# Travel

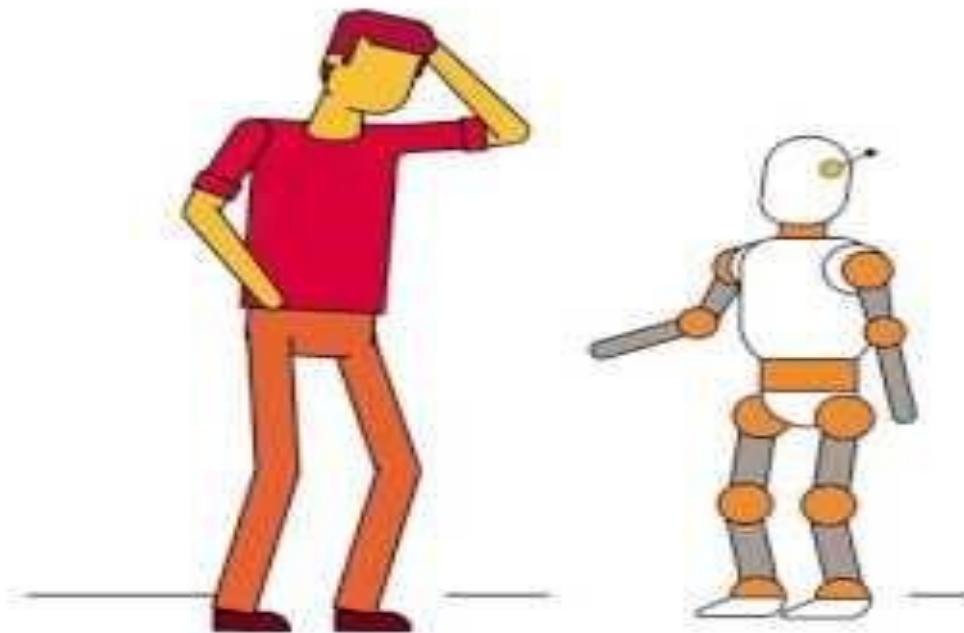
- Hotel Bookings by Voice Command
- AI Concierge Services
  - <https://techcrunch.com/2018/06/19/amazon-launches-an-alexa-system-for-hotels/>
- Travel Service Chatbots
- Check-in Through Facial Recognition
- Self-Driving Cars and Mobility as a Service
  - <https://www.economist.com/international/2016/09/29/it-starts-with-a-single-app>
- Other Robotic Tools





# AI in Healthcare

---





---

# Healthcare

- IBM Watson, Google Deepmind
- At-home testing and personalized health care
- Wearables
- Robot-Assisted Surgery
- Virtual Nursing Assistant
- Administrative Workflow assistance



# Healthcare

- Make quicker diagnoses, create better treatment plans and enable new approaches to insurance
- Identify public-health threats and the most at-risk patients
- help medical professionals diagnose disease and improve operations
- Insurers can devise new ways to encourage preventive care and incentivize providers
- Doctors will be able to tailor treatments—even drugs—to individual patients
- Virtual agents can serve as primary touchpoints for patients
- Several hurdles stand in the way, starting with data availability

## AI in health care: quicker diagnoses, better treatment plans, and improved health insurance



Machine learning program analyzes patients' health remotely via mobile device, compares it to medical records, and recommends a fitness routine or warns of possible disease

Autonomous diagnostic devices using machine learning and other AI technologies can conduct simple medical tests without human assistance, relieving doctors and nurses of routine activities



AI-powered diagnostic tools identify diseases faster and with greater accuracy, using historical medical data and patient records

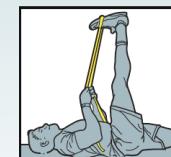
AI algorithms optimize hospital operations, staffing schedules, and inventory by using medical and environmental factors to forecast patient behavior and disease probabilities



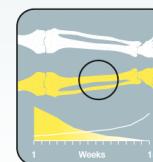
AI tools analyze patients' medical histories and environmental factors to identify people at risk of an illness and steer them to preventive care programs



Virtual agents in the form of interactive kiosks register patients and refer them to appropriate doctors, improving their experience and reducing waiting time



Personalized treatment plans designed by machine learning tools improve therapy efficiency by tailoring treatment to specific patients' needs and medical



AI insights from population health analyses give payers an opportunity to reduce hospitalization and treatment costs by encouraging care providers to manage patients' wellness



# Healthcare – Medical Diagnosis

**Traditionally :** Medical Diagnosis was a challenging process.

- Many symptoms are nonspecific
- Process of elimination was used to determine root cause (neither efficient nor exact)



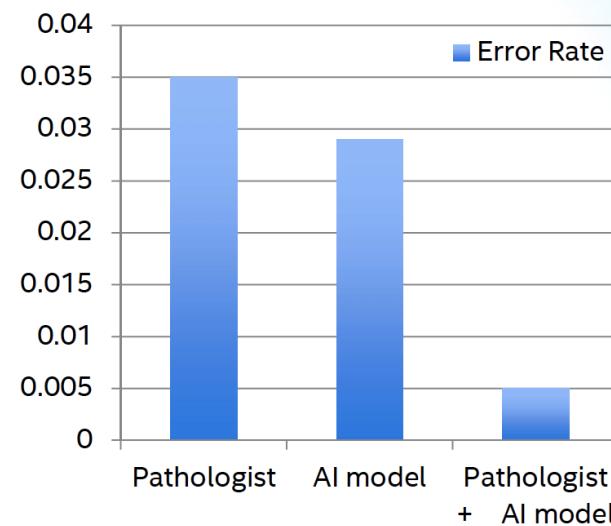
**Now with AI :** Doctors can provide diagnoses more efficiently and accurately, with the availability of:

- Large medical datasets
- Computer vision algorithms



**Example:** Breast Cancer, 2016, Harvard Medical School researchers

- Used DL to identify cancer in lymph node images
- Used Convolutional Neural Nets and custom hardware
- AI model combined with humans achieved lower error than either one individually





# Healthcare – Treatment Protocol

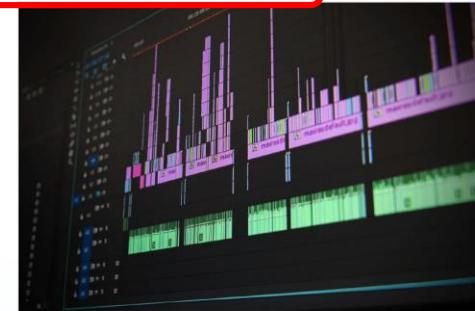
**Traditionally :** Doctors would diagnose a condition and recommend a treatment based on what historically worked for most people.

- Some considerations for population/demographics
- Difficult to create custom treatments without extensive research/cost



**Now with AI :** Doctors can tailor treatments to individual patients.

- Large medical datasets
- ML and DL algorithms
- Population/demographics analysis/simulations



**Example:** ICU Intervene, MIT Computer Science and Artificial Intelligence Laboratory.

- Uses ICU data, from vitals, labs, notes, to determine how to treat specific symptoms.
- Makes real-time predictions from DL models, to provide recommendations for patients.
- Forecasts predictions into the future (a few hours) compared to traditional methods (a few minutes).
- Predictions can be run on common GPU and CPU hardware.





# Healthcare – Drug Discovery

**Traditionally:** Each new drug approval costs over a billion dollars in Research and Development.

- The cost has been doubling every 9 years since 1970
- The drug discovery process can take decades
- 9 out of 10 drug approval attempts fail
- There are currently only 1,500 approved drugs



**Now With AI:** Companies are leveraging structured and unstructured data with AI, to establish a pipeline of new drug discovery.

- There are  $10^{20}$  possible drug-like molecules
- Massive space for potential discovery



**Example:** HetioNet drug discovery model, 2016, UCSF, Himmelstein and Baranzini.

- Developed a graph network to encode millions of biomedical reports.
- Used ML to predict probability of treatment efficacy for ~209,000 compound-disease pairs.
- Provided clear pharmacological insights for epilepsy drug discovery and treatment.





# Robot/AI Surgery



# Healthcare – Surgery

**Traditionally:** Every type of surgery poses possible risks to the patient.

- Adverse anesthesia effects
- Operational complications



**Now with AI:** Semi-intelligent computer systems predict surgical steps, identify complications, and warn surgeons about pending challenges.

- Computer “vision” leverages data from laparoscopic and arthroscopic cameras
- Smart systems automate dictation by generating notes during the surgery
- Surgeons can send point-of-view live feeds of the operative site to experts anywhere in the world for real-time advice.

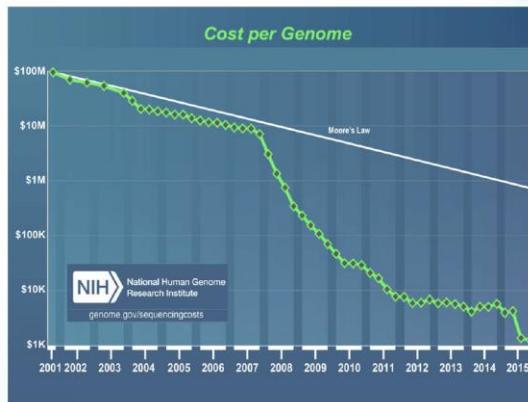




# Healthcare – Genome Sequencing

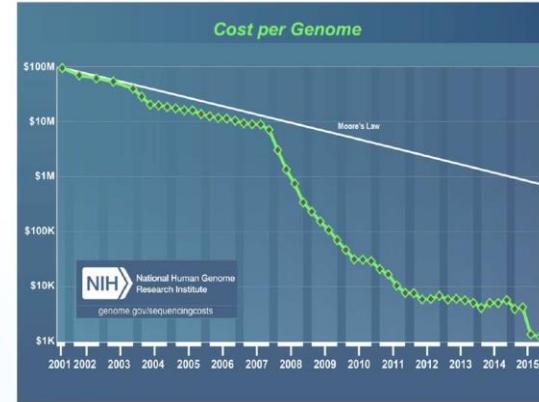
**In 2001:** Full human sequencing cost \$100 million.

- The first genome sequencing took ~13 years



**Now with AI:** Sequence companies are employing AI techniques to reduce cost and increase accuracy.

- Illumina claims that within the near future sequencing will only take 1 hour and cost only \$100



**Example:** Google's DeepVariant\* sequencing:

- Leverages massive data sets together with DL to identify all variants
- Accuracy on genome classification: 99.958 %
- DeepVariant\* is computationally expensive, but the framework can run on GPU hardware, allowing for a faster learning process
- Availability as open source code promises to revolutionize the industry





# Transportation Industry

- Hyperloop
- High-Speed Tunnel Networks
- Self-Driving Cars
- Self-Flying Aircraft





# AI in Transport



**Chinese  
jumbo  
drone  
flies  
humans**



# Autonomous Car

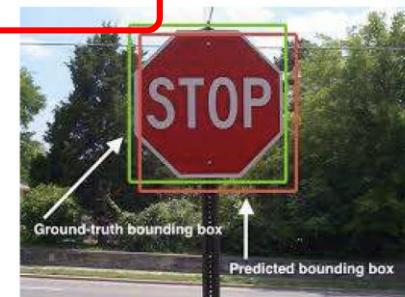
**Traditionally:** Despite having safer cars, the number of deadly car accidents have been on the rise the last few years.

- The leading cause of automobile accidents is human error
- One of the primary sources of traffic jams is each driver acting out of self-interest, that prevents traffic flow
- Part of the population who can't drive: children, the elderly, and the disabled



**Now with AI:** Self-driving cars are enabled by the latest AI breakthroughs in computer vision.

- Cars identify stop signs, lane lines, and other landmarks via DL tools
- Mapping technology can use computer vision to detect addresses
- Cars triangulate and can use other 3D-sensing technologies, such as LIDAR and RADAR



**Example:** Waymo, the autonomous vehicle division of Alphabet Inc.

- Waymo has been operating self-driving minivans without a safety driver since October 2017
- Waymo's Carcraft\* software accelerated the car's development, with 2.5 billion simulated miles driven in 2016
- The system used DL together with massive data sets collected from self-driving cars on public roads





# Automated Trucking

**Traditionally:** There is a shortage of 48,000 drivers nationwide.

- Driver turnover rates at some companies reach 300%
- Truck drivers are twice as likely as other workers to be obese and/or have diabetes
- Truckers are half as likely to have health insurance
- The number of accidents and fatalities have increased in recent years



**Now with AI:** Autonomous trucks can coordinate movements with other trucks.

- Save on fuel, and reduce wind-drag and the chance of a collision
- Video, LIDAR, and accelerometers are used to collect detailed data about the truck's surroundings
- Guidance algorithms provide feedback for braking, steering, and throttling commands, based on incoming and historical data





# Retail Industry

JUST WALK OUT  
TECHNOLOGY

- Intelligent Shopping Systems
- Robots
- Biometric technologies
- Facial recognition





# AI in Retail

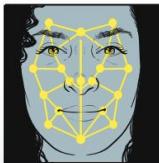
A woman with curly hair, wearing a light gray cardigan over a white top, is shopping in a grocery store aisle. She is holding a brown paper bag and looking down at it. In the background, there are shelves stocked with various grocery items. On the left side of the image, there is promotional text.

INTRODUCING  
**amazon go**

# Retail Industry

- Artificial Intelligence: The Next Digital Frontier
  - 20 percent stock reduction by using deep learning to predict e-commerce purchases.
  - 2 million fewer product returns per year.
  - 30 percent reduction of stocking time by using autonomous vehicles in warehouses.
  - 50 percent improvement in assortment efficiency.
  - 4-6 percent sales increase using geospatial modeling to improve micro market attractiveness.
  - 30 percent online sales increases from the use of dynamic pricing and personalization.

**Retailers can know more about what shoppers want—sometimes before shoppers themselves**



Facial recognition software, machine learning, and natural language enable virtual agents to greet you personally, anticipate orders, and provide directions

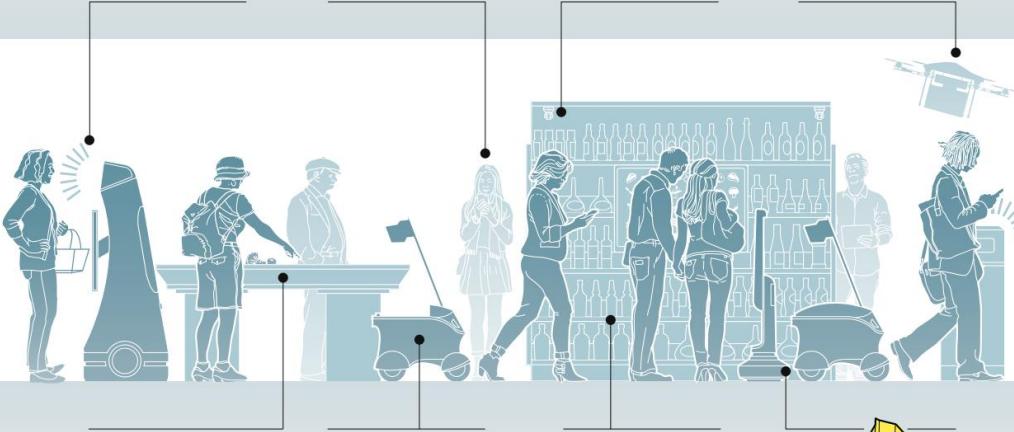
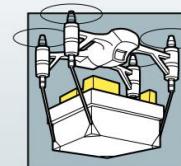


Machine learning personalizes promotions to match shoppers' profiles; in-store beacons send offers to their smartphones as they browse through the store



Computer vision with deep learning identifies articles bagged by shoppers; adding data from sensors, AI allows non-stop checkout and automatic payment

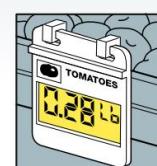
Autonomous drones using deep learning technology complete last-mile delivery, and are able to handle obstacles or absent recipients



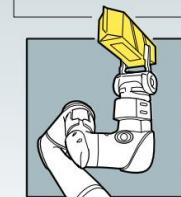
Interactive screens and tabletops enabled with computer vision and deep learning can identify articles and recommend complementary products and uses that fit shoppers' lifestyle profile



An autonomous shopping cart follows you in the store, and can find its way to your vehicle or to a robot or drone for home delivery



Stores update and optimize prices in real time, with machine learning leveraging data on competitors' prices, weather, and inventory levels to maximize revenues



AI-enhanced robots continuously track inventory, recognize empty shelves, and replenish them; other robots fill bags in the warehouse



# Customer Experience

**Traditionally:** Americans are shifting their spending from material goods to experiences.

- The “Amazon effect”: there have been nine major retail bankruptcies in 2017
- Retailers need to become competitive or risk obsolescence
- Balancing “out-of-stock” with “over-stock” trade-off requires great finesse



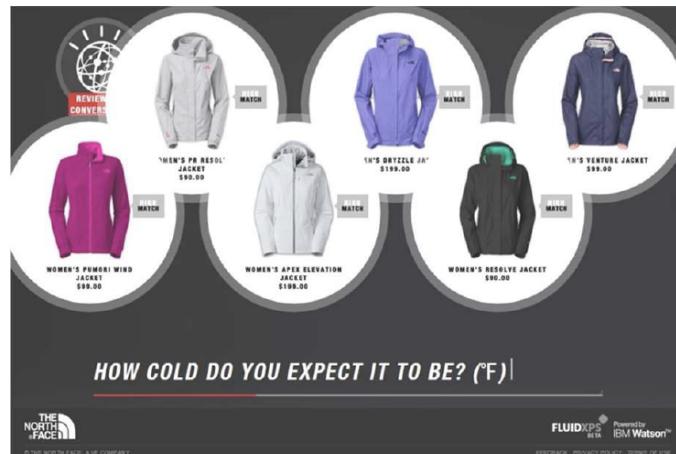
**Now with AI:** Companies bring experience and optimization to retail shopping.

- AI-powered gift concierge learns your preferences as you engage, and can help predict the appropriate gift to buy
- Leveraging ML-trained agents, companies are providing recommendations via natural language
- Companies using AI via Watson\* to monitor factors from weather to consumer behavior, to optimize consumption rate predictions



**Example:** The North Face and Watson\* are combining massive datasets and AI, to bring the brick-and-mortar experience to e-commerce.

- The North Face, with Fluid and IBM Watson\*, has launched XPS\* - an AI-enabled digital expert that uses a natural language interface to help shoppers.
- XPS curates and filters the available options, so shoppers are more likely to make a purchase





# AI in Customer Experience and Supply Chain





# Food Supply Chain

**Traditionally** : Restaurants use historical data or “gut-feeling” approach to supply chain.

- This can result in excessive waste or food unavailability



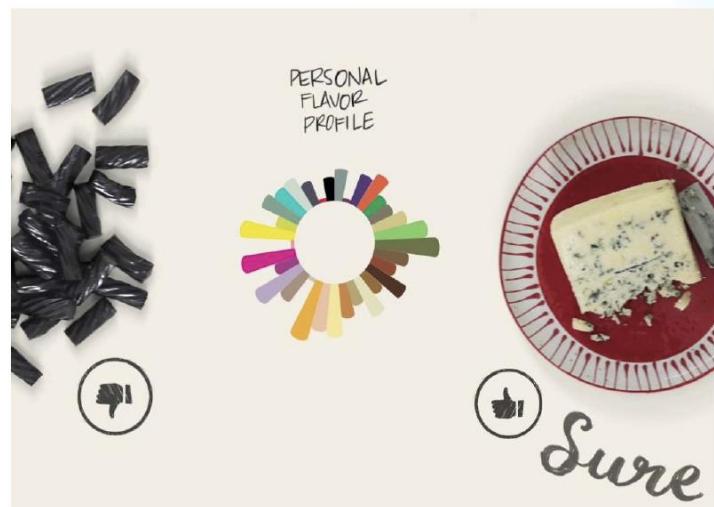
**Now with AI** : Many companies have started to leverage sophisticated algorithms to forecast demand.

- Agents can adjust orders with trading partners in real time, as required for business need



**Example:** Vivanda's FlavorPrint\* program.

- Based on recipes and consumer-provided data, Vivanda maps data to create “digital-taste” identifiers for each consumer
- Providing ML-based recommendations to customers may influence demand
- Shares data with food industry customers, enabling them to improve demand forecasts





# AI in F&B

---



<https://www.youtube.com/watch?v=CAJJbMs0tos>

# Education Industry

- Personalized Learning Platforms
- Individualized Artificial Intelligence Tutors
- Personalized Games
- Crafting a more enjoyable learning experience



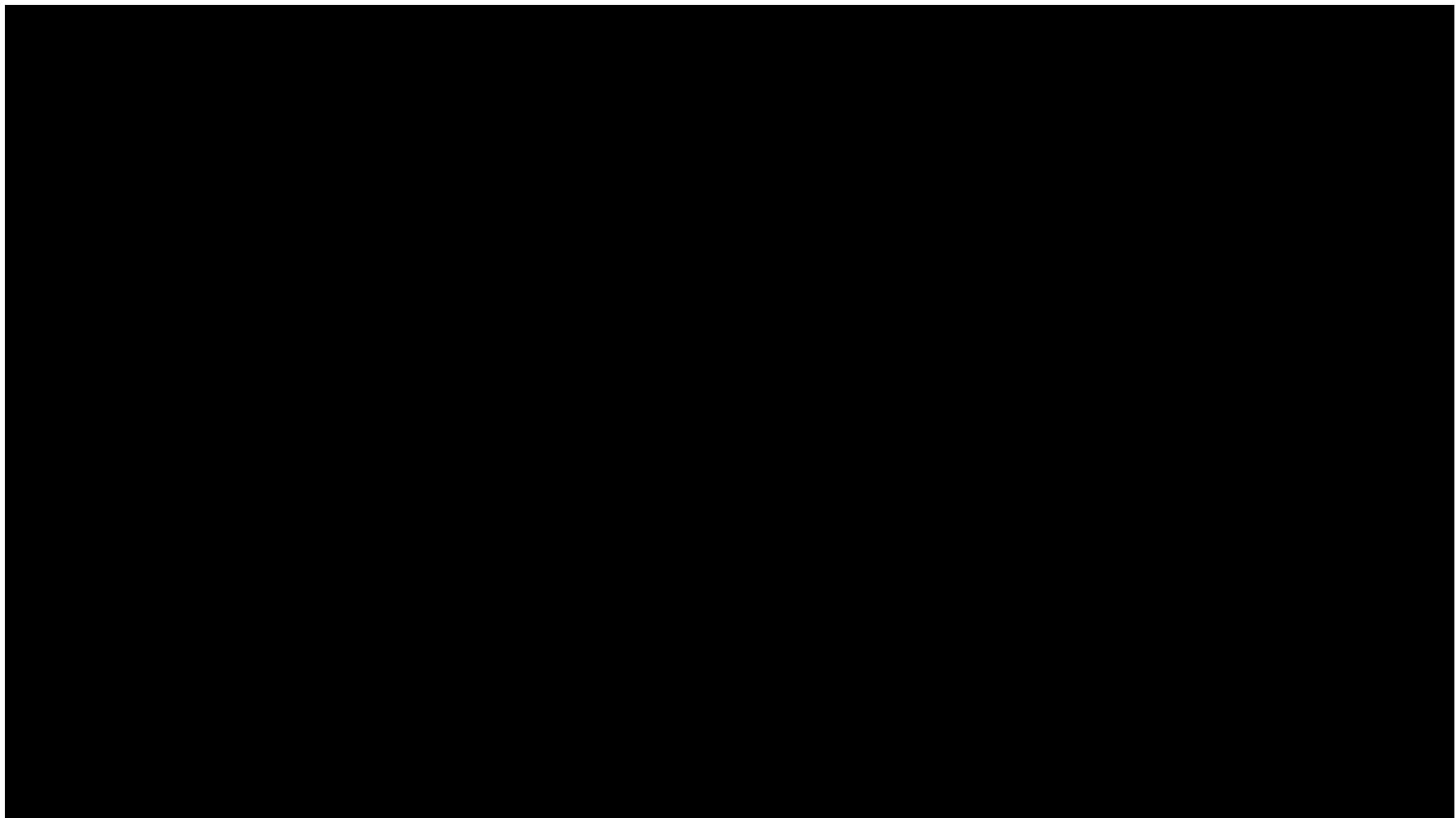
Example: Adaptive learning systems, and grading.

- Learning analytics track student performance and provide tailored educational programs.
- Using natural language processing and ML models, AI programs can be used for long answer and essay grading.



# AI in Education

---





# Agriculture Industry

- Agricultural Drones
- Autonomous Tractors
- Vertical Farms



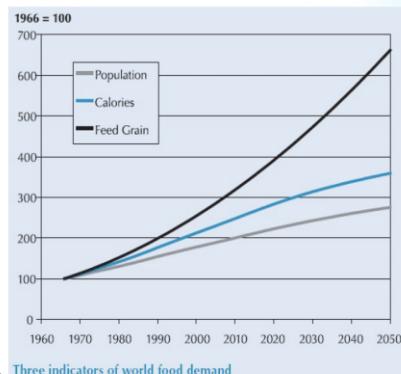




# AgTech

**Traditionally:** The world population is estimated to reach 9 billion by 2050.

- Food production will have to increase by 70% to meet the projected demand.
- Most land suitable for farming is already being used, hence the needed increase must come from higher yields.
- Agriculture must feed the world while not over-straining Earth's resources.



**Now with AI:** Autonomous robots use computer vision and a produce vacuum system for produce harvest.

- DL-enabled robots are being used to identify and kill weeds.
- Companies have shown 90% herbicide reduction due to "targeted" spray application.
- AI-driven genome sequencing advancements enables crop "genome" editing.



**Example:** TellusLabs yield predictions.

- Uses ML together with weather and other historical data to forecast yields.
- Leverages cloud-based GPUs for DL on satellite images.
- TellusLab's predictions have shown to be consistently more accurate than the USDA.
- Came within 1% of predicting corn and soybean yields in 2017.

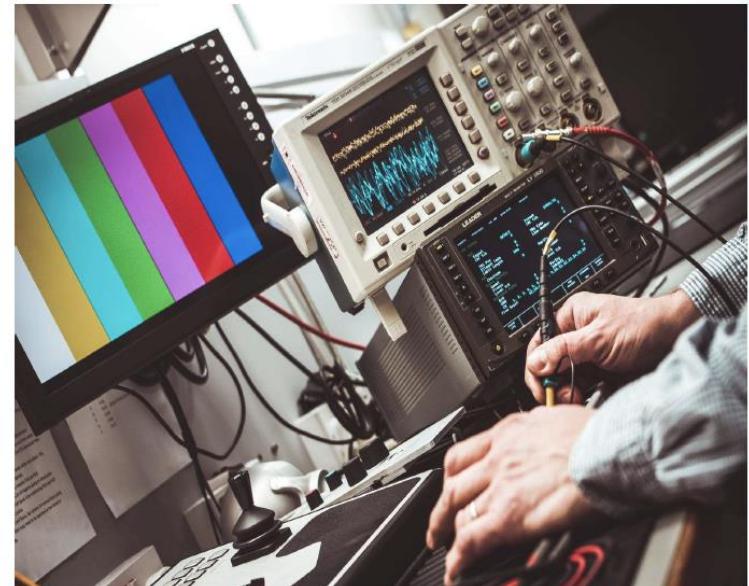




# AI for Music Generation

**Example:** “I AM AI”, first album released in 2017 to be generated by AI – with professional musicians and DL technology.

- Music generation is possible due to special DL algorithms that are designed for sequential data.
- The models learn musical patterns based on learning from large musical datasets.
- Raw music files can be processed on cloud-based computer power, making DL on these datasets possible.

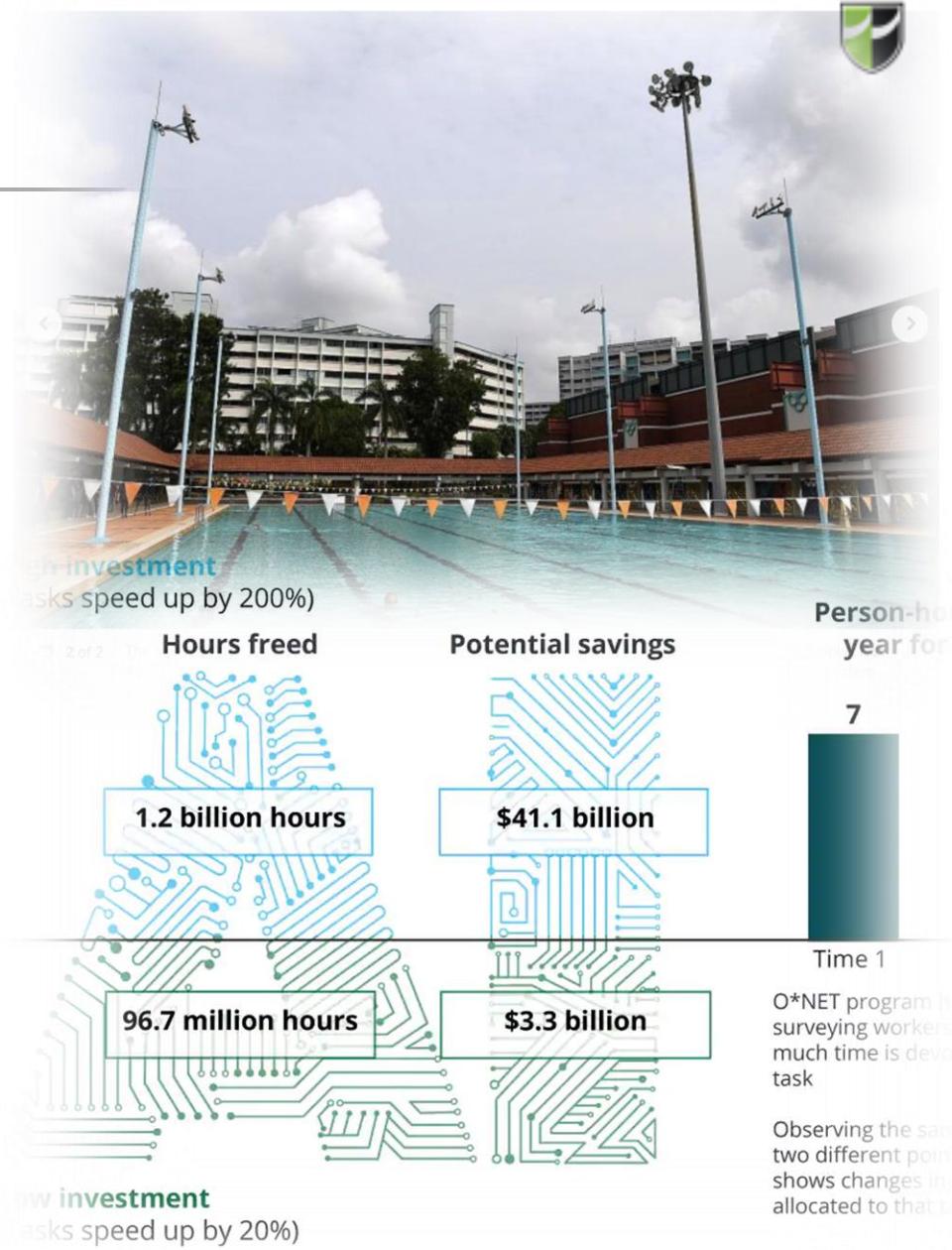


The instrumentation was composed with artificial intelligence, lyrics and vocal melodies written by Taryn. Let us know what you think in the comments!



# Governments

- Public Safety and security
  - Bureaucratic Efficiency





# Smart Cities

**Traditionally:** As of 2008, for the first time in history, half of the world's population resides in cities.

- There are heightened demands on scarce resources.
- Simultaneously, a large part of existing infrastructure is underutilized or not being used efficiently.



**Now with AI:** AI techniques are used to analyze photo and video data to perform studies of pedestrian and traffic trends.

- Adaptive signal control: allows traffic lights to tailor their timing based on real-time data.
- With license plate recognition, and DL technology, cities can not only optimize parking but can also track criminals.



## Example: AT&T reimagines smart cities

- AT&T developed a framework to help cities integrate Internet of Things (IoT) sensors with AI.
- Remotely monitor the condition of roads, bridges, buildings.
- Assist with public safety.
- Notify police if gunfire has gone off, by using sound detection.





# Cybersecurity

---

## Example: Deep Instinct

- Uses GPU-based neural network to achieve 99% detection rates for even the most advanced cyber attacks.
- DeepInstinct's DL models have the ability to detect patterns - mostly designed by humans - enabling the prediction of pending cyber attack.





# Oil and Gas

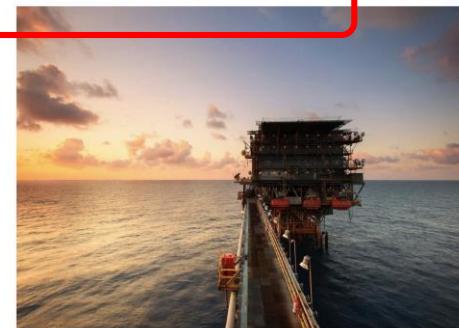
**Traditionally:** Shrinking oil reserves force companies to operate in remote and possibly hostile areas.

- Price has fallen dramatically in recent years.
- Forcing company layoffs and drastic budget cuts.
- Ultimately, companies are in great need of optimizing operations and cost.



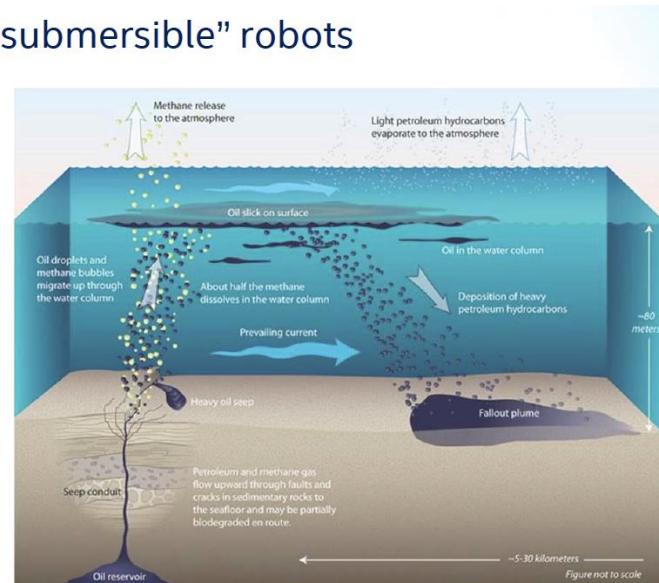
**Now with AI:** AI uses economic, political and weather data to forecast optimum production locations.

- Drilling is still an expensive and risk-prone endeavor.
- ML, with seismic, thermal and strata data, can help optimize the drilling process.



**Example:** ExxonMobile and MIT developing “submersible” robots for exploration.

- AI robots are used in ocean exploration to detect “natural seep”.
- Robots are trained via DL techniques and learn from their mistakes.
- Simultaneously protect the ecosystem and detect new energy resources.

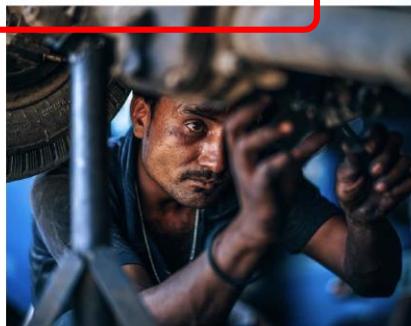




# Preventive Maintenance

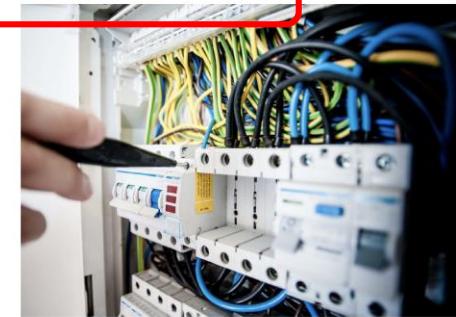
**Traditionally:** Relied on historical data to provide basis for preventative maintenance schedule.

- Conservative approach: parts were replaced well before failure, and thus financially inefficient.
- Flawed due to inability to predict new failure modes.



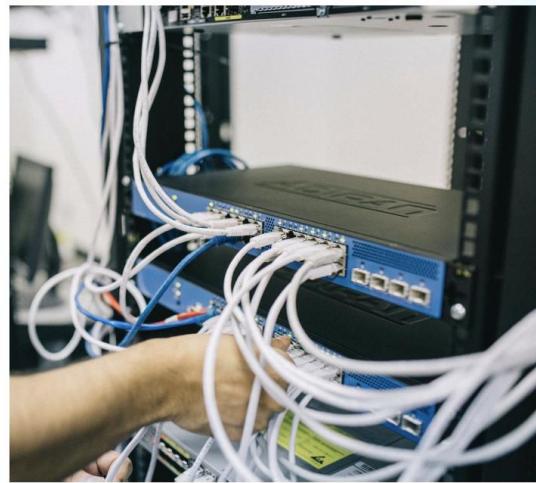
**Now with AI:** Internet of Things (IoT) sensors help to optimize maintenance scheduling.

- Part replacement schedule is optimized by assessing anomalies and failure patterns.
- Safety and productivity can increase exponentially.



**Example:** AI with General Electric.

- GE is the industry leader for Internet of Things (IoT) sensor installations on engines and turbines, and plans to have 60,000 engines connected to the internet by 2020.
- Computer vision cameras and reinforcement learning algorithms find tiny cracks or damage.
- Sensor data and AI allows GE to track performance and optimize part replacement.





# Fault Detection

---

**Example:** Computer vision for fault detection on solar panels.

- DL algorithm trained on labelled data of correctly manufactured vs. flawed panels
- Reduced the need for human inspection by 66% compared to historical need





# AI in Fault Detection



The INNOVATION  
MINUTE

## HOW AI REVOLUTIONIZES DEFECT DETECTION



# Automate Garment Industry

---

**Example:** SoftWear Automation's "sewbots".

- Computer vision is used to track fabric at the thread level.
- Eliminates need for human seamstress / seamster.
- Allows designers to create garments that were previously thought to be too complicated or specialized to construct.





# AI and Customer Service

**Example:** Bot assistants and customer service agents

- AI Augmented messaging.
- AI for sorting and routing inquiries.
- AI enhanced customer phone calls.
- Some companies have used AI to fully automate customer service.





# AI and Next Gen Gaming

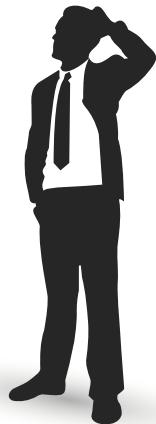
---

**Now with AI:** Forza 5 Motorsport\* uses its “Drivatar” AI system to learn how to drive in the style of other players in the game.

- Neural networks are used to train characters to walk and run realistically.
- Reinforcement Learning (RL) is a technique used throughout gaming.



# What's Next



ONLINE



- › DataCamp  
<https://www.datacamp.com/>
- › Edx  
<https://www.edx.org/>
- › Udemy (freemium course)  
<https://t.me/freecourse>

SHORT COURSES



- › 1-4 days short courses
    - AI
    - Data Analytics
    - IT Security
    - DevOps
    - Software Development
    - New/Digital Media
- <https://www.rp.edu.sg/soi/lifelong-learning>

PART TIME FULL QUALIFICATIONS



- › Specialist Diplomas
    - Applied AI
    - Business Analytics
    - Cloud Architecting & Management
- <https://www.rp.edu.sg/soi/lifelong-learning>

FULL TIME



- › Tech Immersion and Placement Programme in Applied Artificial Intelligence  
<https://www.rp.edu.sg/ace/short-course/Detail/tipp-applied-artificial-intelligence>



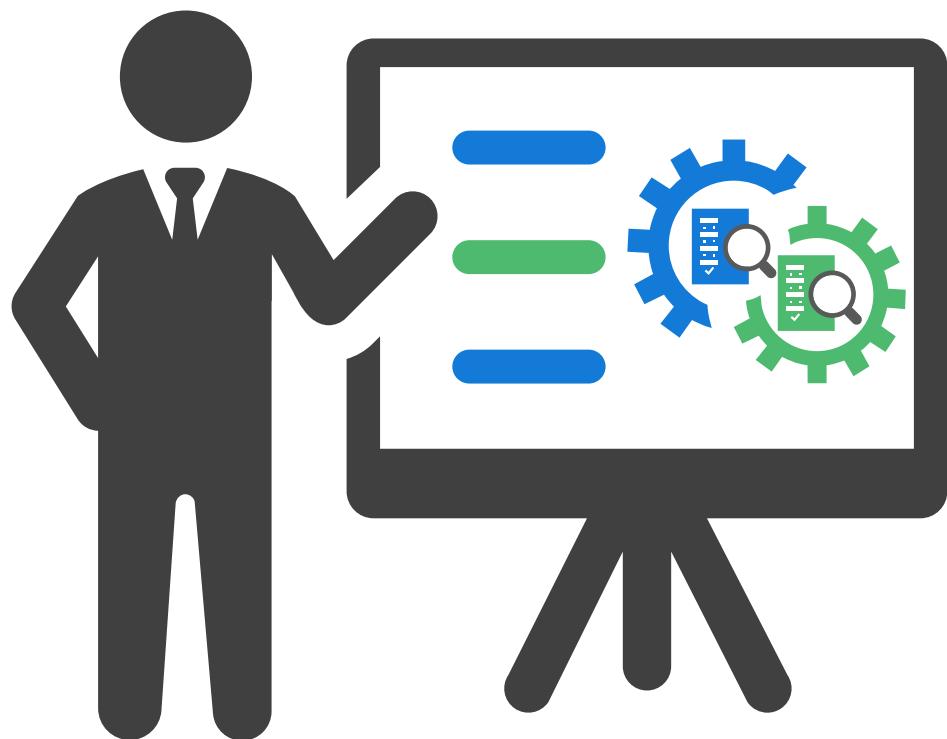
# Survey

<https://bit.ly/2I8aUnA>





# Summary



Email  
[zack\\_toh@rp.edu.sg](mailto:zack_toh@rp.edu.sg)

Telegram  
[@zacktohsh](https://t.me/zacktohsh)

Source code:

192



# Thank you